A SAMPLE SURVEY OF
TUSAYAN PLANNING UNIT 1
KAIBAB NATIONAL FORESTS, ARIZONA

BY

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Fell

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Cultural Resources Report

USDA FOREST SERVICE
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NO. 33

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PREFACE

Sampling continues to be a device for obtaining information on very large land parcels when limited funds prevent complete examination. For some planning purposes sampling data are sufficient including planning for more detailed surveys. This document reports the first stage of a cultural resources sample taken on the Tusayan Ranger District, Kaibab National Forest, Arizona. It is divided into two sections. The first written by Glen Rice deals in a management summary. The second part consists of the technical background with all three authors contributing. Rice wrote the introduction, implementation of the fieldwork, ceramic analysis, and conclusions. He assisted Rick Effland with the lithic analysis and Effland also wrote the geographical and environmental setting, along with the review of the prehistory. Laurie Blank-Roper is responsible for the chapter on the predictive model of settlement pattern distributions. We are pleased with the efforts made, especially those of Glen Rice, to bring this project to a conclusion and trust the reader will find material of interest both archeologically and for management purposes.

DEE F. GREEN
Regional Archeologist

PART I

ARCHEOLOGICAL MANAGEMENT SUMMARY FOR TUSAYAN PLANNING SUB-UNIT NO. 1, KAIBAB NATIONAL FOREST, ARIZONA

Introduction

A one percent stratified random sampling survey of Tusayan Planning Sub-Unit 1, Kaibab National Forest, Arizona has located a total of 26 masonry pueblos, 24 sherd and lithic scatters, 8 lithic scatters and 16 Navajo camps. This management summary addresses the issues of inventory, significance, and long term planning. Despite the low sampling fraction, the survey has produced findings which can generate guidelines for future management of these resources. The Summary is organized into four sections. The first provides a brief description of the study method and area. The second section uses the study results to make statistical projections of the total inventory of resources. This is followed by a brief consideration of the significance of the resources, and the final section summarizes long term planning consideration. A technical report on the survey is presented in Part II.

The Survey and its Setting

The Tusayan Planning Sub-Unit No. 1 is located in the Kaibab National Forest, south of the Grand Canyon (Figure 1). The Survey was conducted in three stages. In the first two, the sampling units consisted of transects which were 1 mile long and 50 yards wide, while in the final stage quadrats of varying sizes were used. The Stage 1 transects were chosen randomly from arbitrarily defined strata consisting of six sections each and are indicated by numbers on the map in Figure 2. During Stages 2 and 3 the location of the survey units was based on judgements to sample specific areas. These units have been given alphanumeric designations on the map in Figure 2. A full discussion of the sampling procedure can be found in the technical section which follows on page 14.

The study area is divided into two distinct physiographic units by an imposing escarpment known as the Coconino Rim. The area to the north of the Rim is called Upper Basin, and ranges in elevation from 6200 to 7200+ feet. The vegetation includes large open areas of sage and grass, pinyon pine and juniper woodlands, and limited areas of ponderosa forest. The topography includes such features as the pediment at the base of the Coconino Rim; flat, plain-like areas bisected by deeply cut canyons; and areas of low ridges and basins.

To the south of the rim is the Lower Plateau. The highest elevations in the study area occur in the Lower Plateau, and the range is from 6400 to 7200+ feet. The area tends to be much more heavily forested than the Upper Basin to the north, and includes ponderosa forests, pinyon-juniper woodlands, and various mixtures. There are limited areas of grasslands,

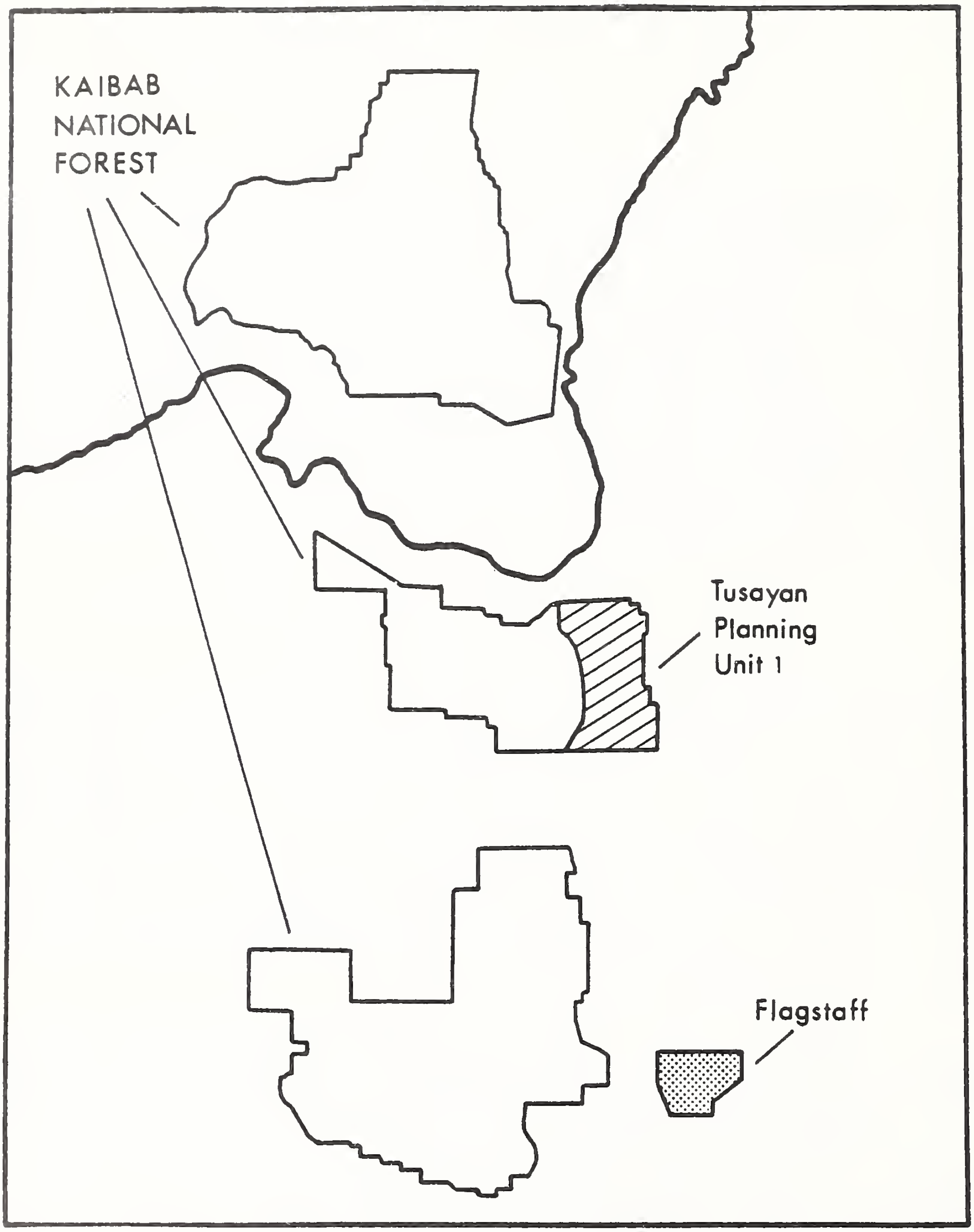

Figure 1. Location of Study Area

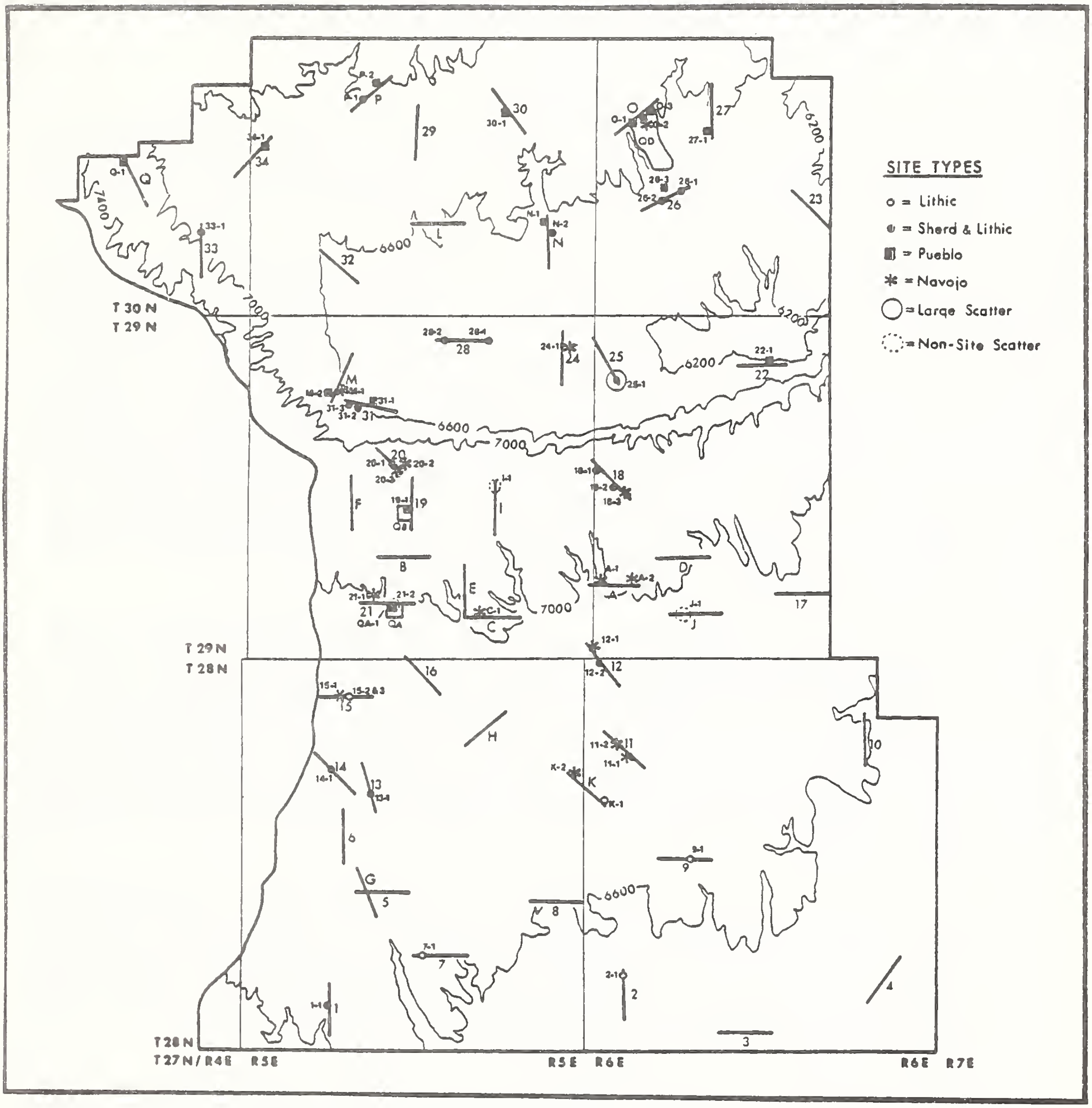

Figure 2. Distributions of Sampling Units, showing site locations.

restricted to narrow basins between low ridges. The topography is varied, but much of it consists of alluvial filled basins alternating with low, linear ridges.

Site densities are correlated differentially with the Upper Basin and Lower Plateau, topography, and vegetation. Knowledge of this variability can be used to assist in planning and in the management of the resource base.

Inventory

The issues involved in developing an inventory of archeological resources include 1) assessing the variability in the resource base, 2) determining the quantity of sites and 3) determining the locational patterns of sites.

Five different types of remains were located by the Survey: 1) masonry pueblos, 2) sherd and lithic scatters, 3) lithic scatters, 4) multiple occurrences of isolated prehistoric artifacts (also called non-site areas), and 5) Navajo camps dating to the historic period. These sites represent the remains of a range of prehistoric and historic activities. For interpretative purposes, the sites are divided into those representing habitation loci, and those representing the remains of specialized and limited activites. Habitation sites are represented by all of the prehistoric masonry pueblos, 9 of the Navajo sites, and an undeterminable proportion of the sherd and lithic scatters. Eight of the Navajo sites and probably a good proportion of the sherd and lithic scatters appear to represent seasonal habitation camps. A single Navajo hogan and the masonry pueblos represent more permanent types of habitation units.

Specialized gathering, hunting and quarrying activities are represented by the isolated artifact occurrences, some of the light density sherd and/or lithic scatters, and by some of the small Navajo sites containing only a single ramada or shade. Another set of specialized activity sites attributable to the Navajo are sweat houses. These consist of low, tepee-shaped structures constructed of logs and covered with dirt. Rocks which were heated in a fire and placed within the lodge can frequently still be found in place. Remains of the fires used to heat the rocks are also a common occurrence.

The quantity of sites can be estimated for various portions of the planning unit by extrapolating from the densities found in the one percent sample. The technical section of this report reviews two procedures for estimating site density. The numbers presented here have been adjusted according to a formula devised by Fred Plog to correct for over-estimations which occur where transect sampling units are employed.

Table 1 compares the relative density of sites per square mile for the Upper Basin and Lower Plateau. With the area of the Upper Basin estimated at 56 square miles and the Lower Plateau at 112 square miles, the projected inventory for the total study area is about 4300 prehistoric and historic sites. A breakdown by areas and site types is provided in Table 2. For consistency, only the transect data were used in developing these projections.

Table 1. Comparative site densities for the Upper Basin and Lower Plateau (Based on Transect Data Only).

Site Type	Upper Basin	Lower Plateau	Total Area
Masonry Pueblos	15.6/sq. mi	.8/sq. mi.	6.5/sq. mi
Sherd & Lithic	14.5/sq. mi	5.5/sq. mi.	8.8/sq. mi.
Lithic		3.9/sq. mi.	2.5/sq. mi.
Non-site		2.4/sq. mi.	1.5/sq. mi.
Navajo	2.6/sq. mi	9.6/sq. mi.	7.0/sq. mi.
All Types	32.7/sq. mi.	22.2/sq. mi.	26.3/sq. mi.

Table 2. Projected site inventories for the study area (Transect data only).

Site Type	Upper Basin	Lower Plateau	Total
Masonry	874	90	964
Sherd & Lithic	812	616	1428
Lithic	-	437	437
Non-site	-	268	268
Navajo	146	1075	1221
	1832	2486	4318

Several distinct distributional patterns are apparent. First, the number and density of masonry pueblos is much greater in the Upper Basin than in the Lower Plateau. In fact, the few pueblos found in the Lower Plateau were on the Coconino Rim overlooking the Upper Basin. The density of sherd and lithic scatters is also greater in the Upper Basin than in the Lower Plateau. The pure lithic sites and the non-site areas (which are also composed principally of lithics) occur in greater densities and numbers in the Lower Plateau. The Navajo camps also occur in much greater density and number in the Lower Plateau.

Site locations also tend to be strongly conditioned by landform. In general, it was found that 60 percent of all sites are found on ridge crests, terraces on the sides of ridges, or on ridge slopes. Flat areas, by contrast, contain only 13 percent of the located sites. The exceptions to this pattern are the lithic scatters and the non-site areas, both of which tend to occur with much greater frequency on flat areas. There are actually two size categories of artifact scatters, and the larger size sites tend to occur on flat areas. This suggests that there is a functional difference within this category of sites, and one of the functions deals with activities conducted on flat areas. Table 3 contrasts the frequency of site locations by different category of landforms.

We have not attempted to quantify the total area of landforms sampled, so that we do not know the proportionate amount of coverage afforded ridges vs hills vs flat areas. However, it was observed in the field that a large majority of transects covered both flat and ridge/hill landform types, and sites rarely occurred on flat areas. It is suggested that all types of landforms were probably sampled with similar thoroughness and that this association can be used for management purposes even though we cannot demonstrate the effect of sampling bias from a strictly statistical standpoint.

Site distributions are also correlated with vegetation types. This relationship is demonstrated in two forms. In Table 4, the observed frequency of sites by zones is compared to the amount of survey coverage provided per vegetation zone. These figures show that there are more sites in the Pinyon-Juniper zone than would be expected, and less in each of the other vegetation zones. The association with Pinyon-Juniper is most pronounced for the three site categories of pueblos, sherd and lithic scatters, and Navajo sites. Lithic sites appear to be less strongly associated with the Pinyon-Juniper vegetation zone, although with the low sample size (7) for this site type, sampling error can have considerable effect.

Table 5 presents the site distributional information as density per square mile for different vegetation zones. The figures are calculated independently for the Upper Basin and Lower Plateau as well as for the study area as a whole. Again, overall site densities are highest for the zones dominated by pinyon and juniper. This is especially true of masonry pueblos, sherd and lithic scatters, and Navajo camps. Lithic scatters occur with nearly equal densities in all of the four vegetation zones.

With respect to inventory considerations, we can summarize the survey results by saying that there are about 4300 sites in the study area consisting of five different types. The five categories have different distributional patterns within the study area. The most pronounced of these

Table 3. Site Distributions by Landforms (Transect Data Only)

SITE TYPE	LANDFORM TYPE		
	Ridge	Hill	Flat
Masonry Pueblo	80%	20%	0%
Sherd & Lithic Scatter	70%	18%	12%
Lithic Scatter	25%	38%	38%
Non-Site Area	66%	0%	33%
Navajo Camps	53%	26%	20%

Table 4. Site Distributions by Vegetation Zone (Transect Data Only)

Vegetation Type	Masonry	Sherd & Lithic	Lithic	Non-Site	Navajo	All Sites	Expected Frequencies Based on Total Survey Coverage
Grassland/ Sage	0%	0%	14%	0%	7%	4%	12%
Pinyon-Juniper	84%	88%	57%	33%	64%	74%	60%
PJ/ Ponderosa	8%	13%	14%	66%	21%	17%	19%
Ponderosa/ PJ	8%	0%	14%	0%	7%	6%	10%

Table 5. Site density per square mile by vegetation zone and physiographic area. Only transect data have been used in making these projections. All of the figures for the Ponderosa/Pinyon-Juniper association are suspect because of low sampling fractions.

Vegetation Zone	Area	Masonry Pueblos	Sherd & Lithic	Lithic	Non-Site Areas	Navajo
Sage/ Grassland	U.B.	0	0	0	0	0
	L.P.	0	0	5.0	0	5.0
	TOTAL	0	0	4.2	0	4.2
P.J./ Sage	U.B.	16.7	16.7	0	0	3.3
	L.P.	1.6	7.9	4.7	1.6	10.9
	TOTAL	8.9	12.1	2.4	.8	7.3
P.J./ Ponderosa	U.B.	12.5	12.5	0	0	0
	L.P.	0.0	8.3	0	4.1	10.7
	TOTAL	2.7	9.4	0	3.1	8.3
Ponderosa/ P.J.	U.B.	25.0	0	0	0	0
	L.P.	0.0	0	6.2	0	6.2
	TOTAL	5.5	0	5.0	0	5.0
All Vegetation	U.B.	15.6	14.5	0	0	2.6
	L.P.	.8	5.5	3.9	2.4	9.6
	TOTAL	6.5	8.8	2.5	1.5	7.0

U.B. = Upper Basin
L.P. = Lower Plateau

patterns is that masonry pueblos tend to occur almost solely in the Upper Basin, while Navajo camps occur almost completely in the Lower Plateau. Sites occur with a high frequency (60 percent) on ridges or hills and with a low frequency on flat areas. The site density patterns are also correlated with vegetation, tending to occur in highest density in areas dominated by pinyon and juniper.

Significance

The evaluation of the significance of archeological and historical sites can be conducted on a variety of bases. The Federal guidelines, as published in the Code of Federal Regulations, 36 CFR 60.6 (1978) by the Advisory Council on Historic Preservation, define a significant site as one which possesses integrity of location and meets one or more of the following criteria:

a) the site is associated with events of importance in American history,

b) the site is associated with the lives of an important personage in American history,

c) the site exemplifies a style of architecture characteristic of a type or period,

d) the site has yielded or is likely to yield information important in prehistory or history.

Archeologists have also suggested other factors which might be taken into an evaluation of significance, including the cultural value to ethnic groups, the monetary value, and the educational and recreational value of the resource (Morrato & King 1976).

Using the Federal criteria, the prehistoric sites can all be considered significant on the basis that they can generate useful scientific information. Site Q-1 may also be significant on architectural grounds, since it represents a relatively rare form (for the area) of larger scale Puebloan construction. This collection of sites in general can provide information about such questions as the prehistoric sequence of occupation in the area, the development and intensification of agricultural subsistence systems, changes in prehistoric social organization, and the reasons for the Puebloan abandonment of the region.

This survey has demonstrated that there are a considerable number of sites in the planning unit and that the great majority of sites are significant for scientific studies. The development of a multiple use management program for the Forest should include guidelines for the accumulation of a uniform data base within Tusayan Planning Sub-Unit One. This would enable the establishment of priorities with respect to the conservation and investigation of sites. Conservation of a sample of the cultural resource base for future uses is necessary, since the nature of archeological investigations and interpretive techniques continue to develop and improve at a

fast rate. The state of the art will change considerably within even the next 50 years, and conserving some sites for future research needs is an important planning goal.

Some types of sites are particularly rare (because of their age, function, location, and so forth) and the conservation of an appropriate sub-set of such sites should be a high priority. Conversely, there are other types of sites which occur in considerable abundance, and even without special efforts a large number of them will be preserved for the future. A sub-set of these sites can be investigated in the present without jeopardizing future research needs. In fact, the investigation of such sites will help advance our knowledge of the prehistory of the region, and an emphasis on using them for current research needs is appropriate.

The cultural resource base can thus be divided into at least two categories; those where the priority is on preservation and those where the priority is on current research. Once guidelines are established, this sort of information can be used when it is necessary to weigh different planning needs. If a proposed road will impact a site with a high research priority, then an appropriate trade-off might be to investigate the site (i.e. mitigate the impact) and then build the road over it. However, if the decision involves a site with a high conservation priority, then the appropriate trade-off would be to move the road and conserve the site.

Such guidelines depend on the development of a regional research design for the planning unit or the Forest as a whole. The design can be incorporated into planning documents for the Forest, and a list of priorities can be identified. The development of such a research design can best be handled by the Forest archeological staff for the area.

The significance and management of the modern Navajo camps is more difficult to evaluate. Their presence on the Kaibab Forest represents an important type of social and cultural information, since it indicates one aspect of the historic patterns of land use. There are, however, two problems. First, many of these sites are less than fifty years old and thus may not qualify for legal protection as historic sites. Second, it is difficult to assess whether these sites contain information which is not already available in more complete and easily retrievable forms elsewhere. For instance, a more thorough account of the activities conducted at pinyon camps can be obtained by visiting such a camp while it is occupied. Ethnographic informants could provide more information about the organization, construction, and layout of the camps than can be reconstructed through archeological studies.

The scientific value of these camps in the late 1970s is not unique, given that there are still more direct and thorough ways of obtaining the same information. However, as the Navajo cultural system changes, it is highly likely that these sorts of activities will cease to be conducted. The significance of such camps for providing information about the Navajo is thus likely to increase with the passing of time.

Using the Federal guidelines, the significance of the Navajo camps lies in the amount of scientific information they can provide about the recent past. This value is currently limited. The presence of the camps provides

a measure of the intensity and distribution of Navajo activities in the Kaibab National Forest, and the camps themselves are probably the best source of that sort of information. The social and cultural information about activities conducted at these camps can currently be obtained more efficiently through other means than an analysis of the material cultural remains found at the camps themselves. As with the prehistoric resources, the development of an overall research design with respect to the Navajo camps could provide guidelines for preservation, documentation, and investigation of a representative sample of the information contained at these sites. The Forest Service will have to decide, however, the degree to which it should pursue such efforts.

While not treated in the Federal guidelines, it is useful to consider three other criteria in evaluating significance. These are ethnic, monetary, and recreation/educational value of the resources.

The significance of a cultural resource to a particular ethnic group requires an identification of value by the group itself. The most directly relevant category of sites in this instance are the Navajo camps. Individuals among the Navajo population would have to be questioned to determine if these locations have a cultural value assigned to them.

The monetary value of the resources can be equated with the cost of a scientific program of data recovery. Two very rough formulas for computing such costs are discussed. They include estimates by volume of excavated material and by person days spent in the field. Using current standards of data recovery and analysis (including screening of excavated material; processing of artifacts as well as pollen, archaeomagnetic, dendrochronological, carbon, and flotation samples; and preparation of full report), one estimate is that a cubic meter of material costs $1000 to excavate and process. A second estimate is based on the number of person days spent in the field. The total cost of data recovery, processing, analysis, and report preparation averages out to about $200 per day spent in the field. Thus if 5 people spend 20 days excavating a site, the total project will cost about $20,000.

Because of the large number of variables which have to be considered in planning the excavation of a site, it is impractical to make an estimate of the costs for the total study area. However, recent excavations conducted by the Office of Cultural Resource Management at Arizona State University suggest the following cost ranges for different site types.

3-5 room pueblo	$32,000 - $40,000
Sherd & Lithic Scatter (Shallow)	$18,000 - $22,000
Sherd & Lithic Scatter (Deep)	$38,000 - $42,000
Lithic Scatter (Deep)	$20,000 - $24,000

The monetary significance of these resources is thus considerable.

The recreational significance of the archeological sites can be realized by developing them as educational displays. Two classes of sites lend themselves most easily to this form of use: The masonry pueblos and the Navajo camps. These sites have readily identifiable features which can be pointed out to the public. Sherd and lithic scatters require an ability to identify artifacts, and thus lend themselves less readily for display purposes. They are also less easily managed. Development of sites for educational purposes must take into consideration the ease of public access, the need for such displays given the proximity of similar displays in the Grand Canyon Park, and the cost of maintaining and servicing such exhibits.

Management Considerations

The archeological resources of Tusayan Planning Sub-Unit #1 can be managed through a combined program of preservation, data recovery, and development as displays. The one percent sampling survey has provided information which can be used to enhance such a program. Specifically it has identified the following characteristics of the resource base and has led to the suggestion of additional studies which could improve the management of the archeological resources.

1. There are about 4300 prehistoric and historic sites in Tusayan Planning Sub-Unit #1.

2. The site types include masonry pueblos, sherd and lithic scatters, lithic scatters, non-site areas, and Navajo camps.

3. The greatest density of prehistoric sites occurs in the Upper Basin, with an average of 30 sites per square mile.

4. The greatest density of Navajo sites occurs in the Lower Basin, with an average of 10 sites per square mile.

5. The overall density of prehistoric sites in the entire study area is 19 per square mile.

6. The overall density of Navajo sites in the entire study area is 7 per square mile.

7. Sixty percent of all sites occur on portions of ridges.

8. Only 15 percent of all sites occur on flat, alluvial plains.

9. With respect to vegetation, the highest density of prehistoric sites occurs in areas of pinyon-juniper and sage. The density averages 24.2 sites per square mile.

10. With repsect to vegetation, the highest density of Navajo sites occurs in areas of pinyon-juniper and Ponderosa. The average density is 8.3 sites per square mile.

11. The great majority of prehistoric sites are significant because of the scientific information they contain about past cultural systems.

12. The development of a regional research design would provide guidelines for establishing priorities on conservation and research.

13. The scientific significance of the Navajo camp is currently limited but could increase in the future. A study undertaken now to document these resources through ethnographic means may be a more efficient way of realizing their significance than attempting to manage them for the future when the ethnographic component of the resource may have been lost. Not all Navajo camps satisfy the temporal requirement for an historic site under Federal guidelines.

14. A study could also be implemented to evaluate the cultural significance attached by the Navajos to the Navajo camps.

PART II
(Technical Report)

SAMPLE SURVEY OF A PORTION OF THE TUSAYAN PLANNING UNIT KAIBAB NATIONAL FOREST, ARIZONA

Introduction

This is a technical report on the results of a one percent archeological sampling survey of Tusayan Planning Sub-Unit #1 of the Kaibab National Forest. The survey was conducted by the Office of Cultural Resource Management, Department of Anthropology, Arizona State University, under a contract with the United States Forest Service. Part I has presented a management summary of the results.

The organization of this report closely follows a format prescribed by the Forest Service. It begins with a description of the survey design followed by a review of the survey setting, the historic cultural development, previous research in the area, the implementation of the field work, and the results of the analysis. The survey findings are summarized by a synthesis of the site patterning over the landscape. The concluding section of the report contains a brief summary of the results and of the management-related concerns which have been addressed by the study.

Location and Purpose

The Kaibab National Forest is divided into three spatially distinct units, as shown in Figure 1. Tusayan Planning Sub-Unit #1 is located in the eastern third of the middle portion of the Kaibab National Forest, in Ranges 4E, 5E, and 6E and Townships 28N, 29N, and 30N. The purpose of the survey was to provide a one percent sample of the cultural resources of the area which could be used for long term planning.

The project was directed by Rick Effland with the assistance of Shereen Lerner. Members of the survey crew included Charles Ames, Frank Bayham, Laurie Blank, Nancy Coulam, Margie Green, Stan Howard, Johna Hutira, Cindy Jobe, Trinkel Jones, Tommasa LoVerde, Robert Miller, Rebecca Nelson, and Deborah Pechin. Glen Rice served as the Principal Investigator. Tom Cartledge, Forest Archeologist for the Kaibab National Forest, served as the Contracting Officer's Authorized Representative and administered the project.

Survey Design

The sampling design employed in this study is that developed and used by Fred Plog and others for the survey of major portions of the Apache-Sitgreaves National Forest. These include survey of the Chevelon area (Plog et al 1976), the White Mountain Planning Unit (Plog n.d.; Donaldson 1975), the Little Colorado Planning Unit (F. Plog 1978), and the Pinedale

Planning Unit (Jewett 1978). In addition, Jeff Hantman directed a survey of the Mogollon Planning Unit during the summer of 1978, and Sherri Lerner has prepared a report on those findings. The design has thus seen wide use, and one of its attractive features is that its continued use will provide comparable survey results for a large part of Arizona.

The sampling procedure is multi-staged and balances a variety of concerns regarding sample size, shape of sample unit, sampling design, and logistics (Plog n.d.).

Stage 1: The first stage uses 1 mile by 50 yard transects in a stratified random sampling design. A number of controlled experiments suggest that transect-shaped sampling units provide more effective statistical information than quadrats (Plog 1976, Mueller 1974, Judge et al 1974). Employing a stratified random sampling design combines the advantages of both a random and a systematic sampling scheme. Randomization helps reduce investigator bias, while systematization insures spatial dispersion of units which is essential in the development of site density maps and for addressing other concerns with spatial relationships. Randomization with an areal stratified universe insures some evenness of dispersion but avoids the potential biases which can occur when a systematic sampling design is used on data with a high degree of periodicity.

The planning sub-unit was divided into arbitrary spatial strata of six sections each. A random selection was first made of one of the six sections and then of one of the 1/4 sections within it. Once a quarter section had been selected, a cultural or natural feature was chosen as an arbitrary starting point. An angle was then randomly selected for the orientation of the transect. These transects are identified by numbers on the map in Figure 2. Upon completion of Stage 1, it was evident that effective coverage had been obtained of the boundaries of the planning unit but there were some areas of poor coverage within the study area itself.

Stage 2: The purpose of the second stage of the sampling design was to obtain additional information about the variation observed in Stage 1. An effort was made to obtain additional information about areas not effectively covered in the first stage, and to develop a better understanding of areas of high and low site density identified during the first stage. Information which would confirm or reject the conclusions drawn after the first stage, as well as information which would lead to the definition of spatial gradients, was deemed critical.

It was obvious that the important emphasis in Stage 2 was to place a number of transects in strategic areas to fill spatial gaps. This was particularly true of the area along the Coconino Rim. The locations of remaining transects were determined on the basis of field analysis performed during Stage 1. The sampling units were transects of the same size and shape as those employed in Stage 1, and are indicated by letters on the map in Figure 2.

Stage 3: While transects are more effective than quadrats in a variety of ways, they are not very informative regarding spatial patterning in the distribution of sites. Stage 3 of the survey design involved the use of

three, non-random quadrats to sample areas of high artifact density or unusual topographic features. Two of these quadrats were 40 acres in size, while a third quadrat was much larger and covered about 285 acres.

The placement of the three quadrats was made on the basis of the following consideration. Quadrats QA and QB were placed close to the top of the Coconino Rim in an attempt to examine more throughly the frequency and distribution of masonry pueblos in that area. Quadrat QB was placed close to Transect 19, which contained a masonry structure, but no sites were found in Quadrat QB. Quadrat QA was placed in proximity to Transect 21, and resulted in the location of a 2 to 3 room masonry structure.

Quadrat QD was located in the Upper Basin next to Transect 0. Three sites had been located on the transect as it crossed a large mesa, and Quadrat QD was intended to serve as a sample of that mesa. Twenty-two sites were found during the survey of Quadrat QD.

The QD mesa is comprised of several superimposed geological strata, as shown in Figure 3. The highest part of the mesa is a siltstone stratum which has very poor soil development. The siltstone bedrock is frequently exposed in large, flat sheets, and as the sheets gradually erode, they break up into large chunks of talus. Surrounding this siltstone spine is a lower stratum of an undetermined material which has deeper soil development and supports high vegetation growth. The soil on this stratum is a light colored tan and is of a silty clay texture. The third stratum is exposed by erosion of the tan colored silt, and consists of a brick-red colored soil. This horizon is exposed in several draws and along the major portion of the eastern ledge. The red soil zone is covered almost completely by artifact deposits, ranging from light density lithic scatters to major midden deposits and masonry pueblos. The fourth stratum consists of narrow rocky ledges on the very edge of the mesa, and received only minimum use in prehistoric times.

The prehistoric settlement pattern is strongly correlated to these variations in topography and soils. The masonry pueblos occur on either the tan or reddish soil (with a preference for the latter), and are frequently placed against the base of a slope. There are three main clusters of masonry pueblos, each of which appears to correspond to an area of good soil in a sheltered draw or protected area. The lithic scatters have a wider range of occurrence than the peublos, but in general the density of artifacts is greatest when the scatter occurs on an area of reddish or tan soil. The scatters in the siltstone outcrop are very light density.

Summary

The sampling survey of the Tusayan Planning Sub-Unit No. 1 in the Kaibab National Forest of Arizona was conducted in three stages. The first two stages involved the use of transects, while the third stage employed quadrat sampling units. A stratified random sampling design was employed for the first stage and a judgemental selection process was employed in stages 2 and 3. The results of the field work are considered below following a review of the pertinent environmental and archeological background.

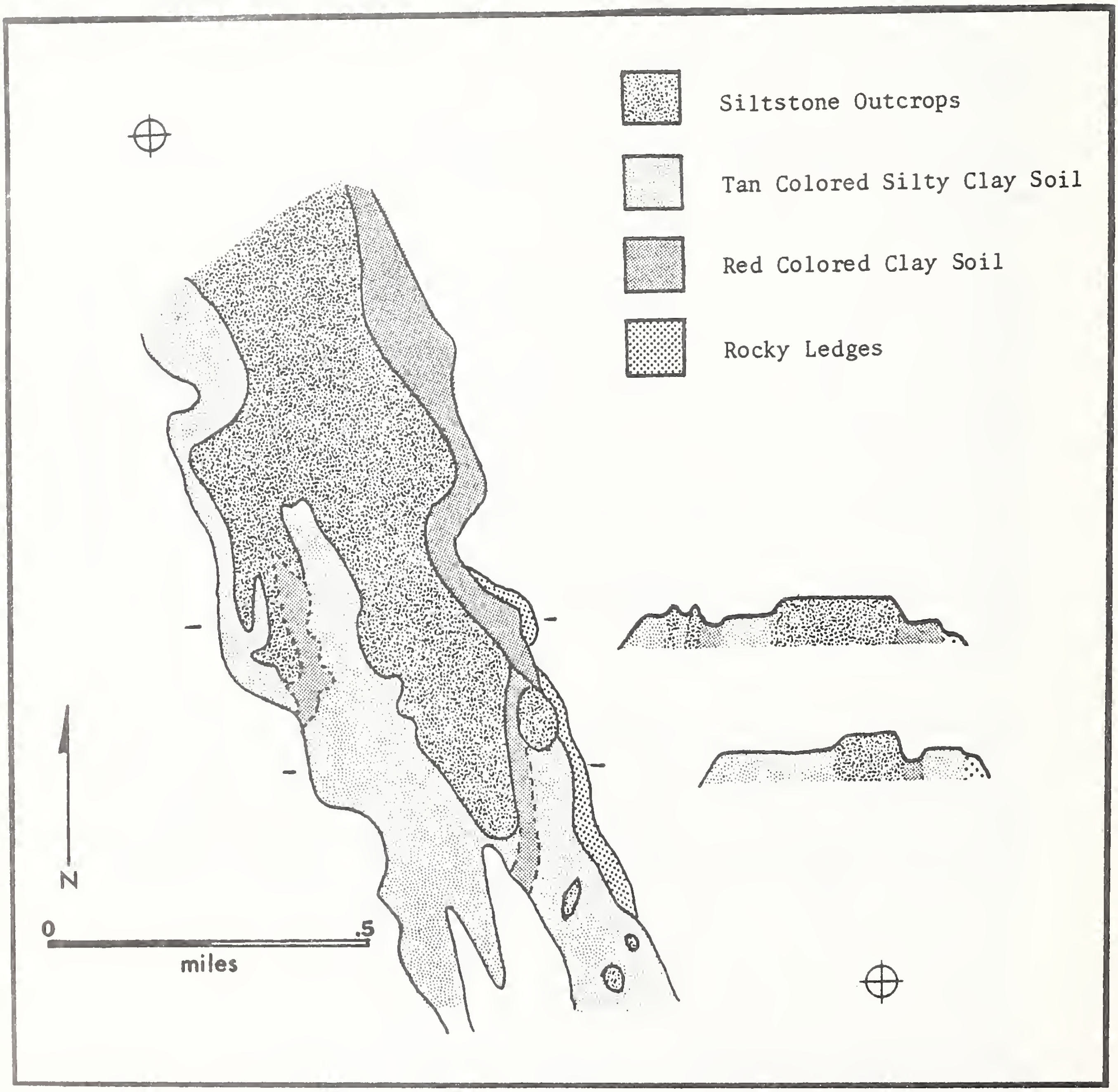

Figure 3. Topography of the QD Quad.

GEOGRAPHIC AND ENVIRONMENTAL SETTING

Tusayan Planning Sub-Unit No. 1 is situated in the north-east portion of the Coconino Plateau, just a few miles south of the Grand Canyon. The topography in general is one of low-lying ridges and mesas separating wide alluvial basins and plains, but the landscape is also dominated by an escarpment of imposing relief which runs in a gentle arc from east to west and which divides the study area into a northern basin and a southern plateau. The escarpment is known as the Coconino Rim, and rises an average of 400 feet in the space of about 1/5 mile. The area to the north of the rim, known as the Upper Basin, constitutes about one-third of the study area and is characterized by deeply dissected canyons, low but relatively steep ridges, and by a large, central plain. Elevation in the Upper Basin ranges from about 6200 to 7000 feet.

South of the rim the topography consists of low-lying ridges separating flat, alluvial basins. Deeply dissected canyons occur only in the very southern portion of the Lower Plateau, and areas of relatively steep topography are lacking. The elevation ranges from 6200 to 7200+ feet.

These variations in elevation and in topography tend to have an affect on the modern distributions of different vegetational associations. There are three major vegetational associations: open areas of sage and blue grama grassland, open woodlands of pinyon and juniper, and forested areas of ponderosa pine. These three associations also grade into each other, and various patterns of dominance/subdominance relationships can occur. Furthermore, poor soil conditions in some areas stunt the growth of trees such as pinyon and juniper, resulting in a low level canopy. This type of woodland is sometimes called a pigmy forest. Figure 4 provides a schematic representation of the vegetational associations, and is based on vegetation maps provided by the Kaibab National Forest.

The Upper Basin contains a large plain in which grass and sage predominates. There are occasional pinyon or juniper trees on this plain, but the overall appearance is one of an open grassland. On the ridges and low mesas which surround the plain, an association of pinyon-juniper with an understory of sage and grass tends to dominate. Elevation rises somewhat towards the western edge of the Upper Basin, and the vegetation changes to a combination of pinyon-juniper and ponderosa. The latter tends to be subdominant.

The vegetation patterns over much of the Lower Plateau form a mosaic pattern corresponding to the topographic system of small basins separated by low-lying ridges and mesas. Soil variation appears to be a major factor affecting this mosaic pattern. Based on field observations, the basins have a deep, alluvial soil which supports a combination of grass and sage. The higher ground surrounding the separating basins consists of a much more rocky, residual soil type, and the vegetation is an open pinyon-juniper woodland. The amount of grassland increases towards the southern portion of the Lower Plateau, partly in response to lower elevations and partly because the amount of alluvial soil increases. In the north-western portion of the Lower Plateau there is a rise in elevation, and ponderosa forest with an understory of sage begins to dominate. There are also areas of combined ponderosa and pinyon-juniper occurring within the boundaries of the ponderosa forest zone.

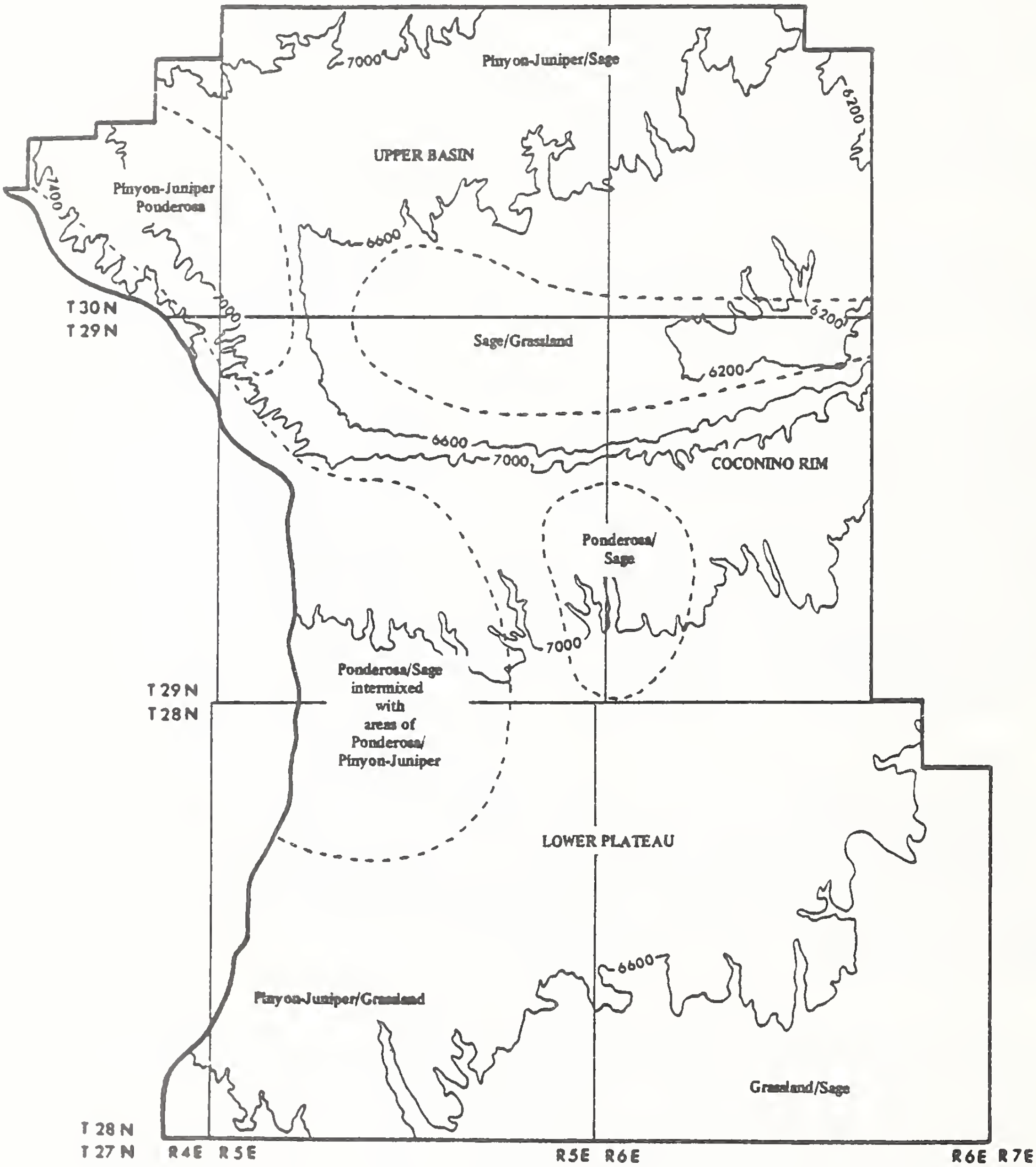

Figure 4. Vegetation Associations in the Study Area.

The faunal constituents of the Coconino Plateau include mule deer (Odocoileus hemionus), pronghorn antelope (Antilocapra americana), coyotes (Canis latrans), jack rabbit (Lepus sp.) and various squirrels and other rodents. The deer population tends to winter in the pinyon-juniper woodland, moving to higher elevations during the summer (Shelford 1963: 287). Rabbits prefer grassland areas, while the distribution of predators such as the coyote is dictated by the availability of such prey as rodents and deer.

Precipitation in the study area, as with much of the Coconino Plateau, comes in the form of highly variable winter snowfalls, primarily between January and March, and late summer rainfall. The average annual precipitation is 15.8 inches (385mm). The months of April and May are particularly dry, usually averaging less than 1 inch per month. Soil moisture at the start of the growing season is thus derived primarily from the winter snow melt (Jennings 1971:19-20).

The hydrography of the Coconino Plateau has been discussed in some detail by Strahler (1944). There is a definite scarcity of permanent streams, springs, or seeps on the Coconino Plateau and modern communities in the Grand Canyon National Park are supplied either by trucked water or by a pipeline from a spring on the north rim. Also, while the average precipitation is relatively high, the moisture for any one year can be highly variable. The amount of snowfall from year to year is very variable, while summer rainfall tends to occur as highly localized and brief thundershowers. It is possible that some areas on the Plateau will receive only a trace of moisture while others will receive great amounts. A subsistence system involving an intensive reliance on agriculture would face serious logistical and decisionmaking problems.

The Coconino Plateau has a relatively cool climate, with a high degree of variation between night and day temperatures. Average monthly temperatures range from 29.4° F in January to 69.2° F in July. The mean annual temperature is 48.7° F. There are, on the average, 148 frost-free days per year, which represents a relatively short growing season.

The environment of the study area presents a high risk situation for agricultural subsistence practices. There are, however, a variety of wild food products which could have been exploited prehistorically, and used either as the main diet by small populations of hunter and gatherers, or a means of compensating for the unpredictability of cultigens by larger populations of agriculturalists. These natural food products include pinyon nuts, juniper berries, deer, and antelope. Under such conditions, it might be expected that the distribution of prehistoric sites would reflect as much a concern for access to natural food resources as to good agricultural land.

REVIEW OF THE PREHISTORY OF THE GRAND CANYON REGION

Preceramic Occupation of the Region

The only survey which has taken place within the planning sub-unit was that conducted by Calvin Jennings (1971) during 1966 and 1967. This survey was done in conjunction with the construction of the Arizona Public Service Company's 500 kV power line across northern Arizona. A total of 92 sites were recorded during this survey of which 35 were found on the Coconino Plateau.

Excavation data derived from this work is significant since it represents a major effort to test the preceramic sequence for the plateau. Jennings' work provides the principle insight into the occupation of the area by Archaic populations. His data suggest occupation in the area as early as 4000 B.P., making the material contemporary with more southerly Chiricahua-Armagosa II material from Ventana Cave (Haury 1956). Projectile points associated with this early period by Jennings consist of stemmed, concave-based types and corner-notched types. Jennings labels this time period, between 1900 and 1000 B.C., as the Red Butte phase. It is followed by what he calls the Red Horse phase, dated from 700 B.C. to A.D. 250. Concave-base points no longer are associated with Red Horse phase materials. Stemmed and flat-based points are still present, as well as a predominance of side-notched blade points. In all cases, the bases of the points are flat or convex in shape. Jennings' final preceramic phase is the Hupmobile phase which is dated from A.D. 250 to 700. Stemmed points have disappeared, and side-notched and unstemmed and unnotched points predominate. McNutt and Euler (1966) have also reported on a series of early archaic sites in the vicinity of Red Butte.

Evidence regarding the subsistence of these preceramic populations is scant; however, it is suggested that these populations relied heavily on hunting and gathering as a means of survival (Jennings 1971:472, 474, 478-9). The area of the Coconino Plateau is highly suitable for such a strategy. The rich pinyon pine pygmy forests and the other abundant flora and fauna of the plateau should favor a hunting and gathering subsistence pattern. Hunting and gathering activities are also assumed to have been important for the later ceramic occupations as well.

The relationship between the preceramic manifestations identified by Jennings and the caches of split-willow and cottonwood twig figurines from caves within the Grand Canyon (Euler and Olson 1965) can only be hypothesized. These caches, found in the caves of the Mississippian Redwall formation, are the only trace of the people who used the Inner Canyon some 3000 to 4000 years ago (Euler and Chandler 1978:73). To date, however, no diagnostic artifacts have been found in direct association with the twig figures nor have habitation or limited activity sites been recorded. Use of the Canyon was probably limited to sporadic hunting and gathering during this preceramic stage. It is hypothesized by Euler and Chandler (1978:73) that there was a lengthy hiatus between the early use of the Canyon and the later Anasazi-Cohonina occupations.

Anasazi

The Anasazi cultural group which occupied the northern portions of Arizona, southern Utah and fringes of Colorado and New Mexico is represented in the Grand Canyon region by the Kayenta branch (Euler and Chandler 1978:73). In the area south of the Canyon, the Kayenta branch represents the western most extension of the Anasazi. The Kayenta occupied the Kaibab and Coconino Plateaus and the eastern portion of the Inner Grand Canyon.

Anasazi material obtained from the area of the Grand Canyon tends to fall within a time span between about A.D. 800 and A.D. 1200, a period from late Pueblo I times to early Pueblo III (Schwartz 1969, Euler and Chandler 1978). Data from the area seem to be consistent with the general trends in the evolution of Anasazi settlement pattern; specifically, a shift from large numbers of small habitation units to fewer and larger sites seem to occur (Schwartz 1969). The pattern of settlement also suggests a relatively clustered arrangement of small unit style pueblos (Schwartz 1968). This is a pattern that gradually changes after A.D. 1150 to one where populations tend to agglomerate into large, multi-roomed pueblos.

Anasazi sites in the area range from a single room to over 25 or 50 rooms. Plazas, kivas, and courtyard features are found. Construction styles include coursed masonry which varies in terms of building materials and forms. Cobble masonry forms are typical for the area, but other Anasazi forms using prepared masonry slabs also occur.

A conspicuous absence of pithouse features is a characteristic of this western fringe area of the Anasazi. Two pithouse structures have been noted by Jennings just east of the Little Colorado River (Jennings 1971: 35). All other depressions observed in the area are directly associated with unit pueblo architecture. In addition, the existing data suggest that fewer kivas are found in the Grand Canyon area than are known to the east where they are found quite often in association with unit pueblo sites.

Cohonina

The Cohonina occupation of the Grand Canyon region appears to fall primarily within the western reaches of the Canyon and to the west of the planning sub-unit (Euler and Chandler 1978:73). However, the exact extent of the Cohonina is not well known. One of the intriguing unsolved questions in Grand Canyon archeology focuses on the Cohonina distribution in relationship to the local Kayenta occupation. The Cohonina appear to have lived in the area from A.D. 600 to 1150 (Schwartz 1966). However, what happened to the Cohonina after about A.D. 1150 is a question of some debate (Dobyns 1956; Dobyns and Euler 1960; Euler 1958; Schwartz 1954, 1955, 1956, 1959, 1966; Whiting 1958). Several possibilities have been suggested: 1) they may form a direct line to the later Cerbat and Havasupai occupation in the area, 2) they may have abandoned the area as did the Kayenta, or 3) some combination of these two may have occurred (Whiting 1958). Some evidence for all three possibilities seems to exist at present. Principally, the geographic similarities between the Cohonina

distribution and that of the later groups supports the idea of continuation. As Dobyns and Euler have pointed out, however, several important changes occur both in the material culture and in the land use patterns between the groups (Euler, personal communication).

This latter point has led Green and Euler (1978) to conclude that there was a migration by the Cohonina pouplations around A.D. 1150 followed by a 150 year hiatus. It is not until around A.D. 1300 that Cerbat populations begin to use the western Grand Canyon area. Prior to this time these populations occupied the riverine and desert environment to the west of the Coconino Plateau.

No matter how one accepts the cultural sequence between A.D. 1000 and A.D. 1300, it is clear that the later Cerbat populations, which inhabited a territory from the Black Mountains bordering the Colorado River to the Little Colorado River and from near the Bill William Fork northward to the Grand Canyon, did have a relatively stable culture. In historic times, they have been recognized as belonging to the Pai tradition, the Walapai and Havasupai (Euler 1976).

Cerbat subsistence seems to be largely based on hunting and gathering of wild resources and agriculture focused on spring-fed irrigation. Their varied subsistence base has been hypothesized as an adaptive mechanism which allowed the Cerbat populations to exist in a marginal environment for at least 1100 years.

For the purpose of this report, the main concern involving the Cohonina is a definition of their use of the area surrounding the planning sub-unit. First, Cohonina use of the Inner Grand Canyon is markedly different from that of the Kayenta to the east. Specifically, Cohonina use seems to be limited to rock shelters directly associated with large agave roasting pits (some of which are up to 10 m in diameter) (Euler 1976). Second, Cohonina land use on the South Rim is poorly understood, but the types of sites encountered differ from those of the Kayenta (Euler 1976). Cohonina habitation sites consist of small rubble or cobble masonry structures with quite varied plans. Often, simple ramada structures with boulder outlines, assumed to be jacal structures, are found (Euler 1976). Third, there is no definite evidence of ceremonial structures in association with Cohonina sites (McGregor 1951).

Admittedly, this is a very cursory overview of the Cohonina. A much more detailed discussion of the Cohonina can be found in Jennings (1971), McGregor (1951, 1967) and Schwartz (1955).

Late Prehistoric and Historic Use of the Area

In addition to the late Havasupai occupation of the area around Cataract Creek and Havasupai Canyon, there has been temporary use of the region by prehistoric and historic Hopi, Pai and Navajo groups (Jennings 1971:36-41). The Hopi have a documented trade relationship with the Havasupai, and also consider the area to have important ceremonial and natural resources. The Navajo have used the area, and particularly the eastern edge of the Planning Sub-Unit No. 1, for both habitation and limited gathering activities. There is ethnographic information which suggests a relatively

strong reliance on the eastern planning sub-unit as a rich pinyon gathering area of Navajo from the Page, Cameron and Shonto areas (Scott Russell, personal communication). Jennings' survey found several camps in the area which tend to substantiate this.

Summary of Prehistoric Land Use

Limited survey of areas to the south of the Grand Canyon have begun to give a broader perspective to the culture history of the region. Shumate, Smith and Wood (1975) and Jennings (1971) have contributed the only systematic survey information. Both of these surveys were limited in scope, but these data, along with that compiled for miscellaneous spot surveys, provide some insight into the prehistoric occupations of the study area.

The area to the south of the Grand Canyon appears to have had a lengthy and continuous occupational sequence. At least, the evidence gathered by Jennings (1971) suggests a relatively continual occupation and use of the area. Jennings, on the basis of data excavated from several stratified rockshelter deposits, hypothesized the following sequence: Red Butte phase (2000 to 1000 B.C.), Red Horse phase (750 B.C. and A.D. 250), Hupmobile phase (A.D. 250 to 700), and Cohonina phase (A.D. 700 to 1200). The morphological changes in projectile points and other functional classes of tools point to a continuum of occupation by hunting and gathering groups within the region prior to A.D. 700. After this point, Jennings suggests that a greater reliance upon agriculture developed within the area. Although this developmental sequence seems reliable, the actual dates proposed by Jennings for these phases are questionable since they are based primarily on obsidian hydration, a technique which has recently proven unreliable for this area (Euler, personal communication).

Examination of the economic use of the region for a wide variety of subsistence activities may provide an alternative framework for examining the culture history of the region. The period prior to A.D. 1000 can be termed a period of hunting and gathering. Evidence suggests that the populations in the region largely relied upon the abundant wild resources and game within the area for their subsistence. At the very least, a great majority of their activities were directed toward hunting and gathering exploitation.

Between A.D. 1000 and 1150, two patterns seem to emerge. One, a Kayenta Anasazi pattern, appears to develop along the eastern half of the Coconino Plateau, Inner Canyon and the North Rim areas, and involves a major dependence on agriculture. The second, a Cohonina pattern, develops within the western reaches of Coconino Plateau and Inner Canyon. Based on the evidence from the western Grand Canyon Esplanade, this pattern appears to be less dependent upon agriculture. While Cohonina activities are relatively poorly understood outside of the canyon area, the evidence within the Inner Canyon suggests quite strongly that there were two patterns developing during this period.

There seems to be some confusion about what transpired following A.D. 1150 or 1200. The occupation by Kayenta populations lasted until sometime after A.D. 1200 along the rim areas, or at least along the South Rim. There, the

population began to agglomerate into a limited number of pueblo structures before abandonment shortly after A.D. 1200. Specific determination of what actually happened in the western area depends upon the position taken regarding the links, or lack thereof, between the Cohonina and Cerbat (Havasupai) populations. Cerbat use of the Esplanade after A.D. 1300 certainly suggests a use of Inner Canyon resources which was similar to but less intense than that assumed for the earlier Cohonina.

The Cerbat, and later still, the Havasupai use of the area can be characterized as mixed hunting and gathering and horticulture. The Havasupai use of the Inner Canyon and rim areas on a summer and winter pattern is suggestive of possible prehistoric land use patterns for the area.

In conclusion, the Coconino Plateau, and particularly the area within the Planning Sub-Unit No. 1, provides a rich environment for exploitation. It does not favor horticulture since it has a very short growing season, little available permanent water, poor soil conditions and unreliable snow and rainfall regimes. It does, however, directly favor other use of the area with a wide range of exploitable resources, both floral and faunal. The Tusayan Planning Sub-Unit No. 1 area is very important for better understanding the relationships of land use patterns along the South Rim of the Grand Canyon. The Canyon, itself, provides an extension of the Coconino Plateau resource base. The Canyon rims, both north and south, can be viewed as ecotonal environments. The rim areas, which exhibit the strongest and latest Kayenta occupations in the region, favored settlement since they provided direct access to the plateau forests and the Inner Canyon. Both of these environments could have provided an added dimension to subsistence of both the Kayenta and the Cohonina populations just as it did for the ethnographic Havasupai.

It is obvious from this brief overview of the prehistoric land use of the region that several major questions need to be answered. The questions can be stated as follows: What were the changes in land-use patterns from the PaleoIndian through the Archaic and into the Puebloan periods? What were the relationships between the contemporaneous Cohonina and Anasazi occupations? How did the patterns of land use differ between these two groups? And what were the effects of the Grand Canyon on the people who settled along the rims?

IMPLEMENTATION OF THE FIELD WORK

Introduction

Implementation of the field work involved the execution of two different sets of procedures; those dealing with survey practice, and those dealing with data collection. This chapter involves a discussion of the particular procedures employed in the survey of Tusayan Planning Sub-Unit No. 1. The sampling design for the survey follows that previously employed by Plog and others for coverage of major portions of the Apache-Sitgreaves National Forest in central Arizona. As was already pointed out in the introductory chapter, the advantage of adopting this existing design (aside from its demonstrated utility and efficiency) is that the Tusayan survey results will be comparable to a large body of existing data.

There was, however, one departure from the Plog design in the Tusayan survey, and this was with respect to data collection procedures at individual sites. When conducting surface collections of materials at sites, Plog (1978:22-23) has tended to employ randomly oriented transects through the center of each site. In the Tusayan survey, surface collections were made in 2 by 2 meter quadrats which were located on the site using a stratified, random sampling scheme. It is felt that the latter procedure improves the sample by providing better controlled spatial coverage of the site. It is more time consuming than the transect procedure, but in this study at least the difference was not sufficient to lessen the efficiency of the survey. There is thus some loss of comparability between the Tusayan and other data sets, but it is in the context of intra-site relationships and not inter-site patterning.

Survey Procedures

The survey was conducted according to the design discussed in the introductory chapter to the technical section of this volume. The survey crews normally consisted of teams of three people, such that six longitudinal traverses were made of each transect. One member of each crew was equipped with a Silva compass which he or she used regularly to maintain the appropriate transect orientation. Another member of the crew flagged the centerline of the transect on the outward bound traverse, so that the return traverse could be done without the aid of a compass.

A two page form was used to record information about the transect. On the first page information was requested about the crew personnel, date, location, vegetation associations observed, topography, amount of usable land, water resources, and the characteristics of the observed cultural materials. The second page provided space for a sketch of the transect in cross-section and in plan view. The former was used primarily to provide a feeling for the relative rise and fall of the terrain, while the latter was used to plot the relative spatial arrangements and occurrences of cultural phenomenon.

Sites which were encountered during the survey were mapped and a sample collection was made of the surface artifacts. The procedures for accomplishing this are discussed more fully under the heading of "data collection." The location of the site was also recorded on a map. The sites were visited again at a later date, and their locations were also recorded on aerial photos provided by the Kaibab National Forest.

A primary concern in the implementation of any survey is the intensity of coverage. F. Plog, S. Plog, and Wait (1977) have shown that there is a strong correlation between the number of sites reported in a survey and the distance of the spacing between individual surveyors. While complete coverage of the surface may not be economically feasible in many cases, it is clear that the spacing between individuals should be well below the median site diameter.

A measurement of median site size was not available prior to this study because of the lack of an existing sample. It was known, however, that a number of the sites would consist of small pueblos of only a few masonry rooms and a small associated artifact scatter. Accordingly, the spacing between surveyors for this study was set at 15 to 20 meters. Assuming that an individual is likely to see artifacts in a two meter corridor to each side, this would imply that some small sites measuring less than 11 meters in diameter would have been missed.

Having completed the survey, it is now possible to evaluate the relationship of site size to intensity of survey coverage for the Tusayan Planning Sub-Unit No. 1. The frequency of observed site diameters for three different types of sites are compared in Figure 5. If we had an ideal situation in which we had complete coverage for all sites, we could expect the shapes of such graphs to fit one of three basic patterns: 1) the range in site sizes could be normally distributed around the mean; 2) the range could be skewed towards the high range of values; 3) it could be skewed towards the low range of values. A bias in survey coverage could result in the last case if the median site diameter fell below the size of the uncovered corridor between surveyors (which in this case ranges between 11 and 16 meters). What would happen, given such a situation, is that the surveyors would encounter some of the sites with less than 11 meters diameter, but they would much more consistently find the sites with diameters greater than 11 meters. Thus a curve based on survey data which shows low frequencies of sites in the below 11 meter range, and a sharp rise in frequencies of sites in the 11 to 16 meter range, may be reflecting a situation in which the lower range of site sizes have been inadequately covered. Conversely, if the maximum peak in site diameter is well beyond the 11 to 16 meter range, the effect of spacing between surveyors will have been negligible. The same conclusion can be drawn if the maximum peak is below the 11 to 16 meter range, since then it is clear that small sites were observed.

Looking at the graphs in Figure 5, we find that maximum peak for the diameter of artifact scatters does in fact fall in the 11 to 16 meter range. While this curve may be an accurate reflection of reality, it is also possible that it represents a situation in which site diameters are

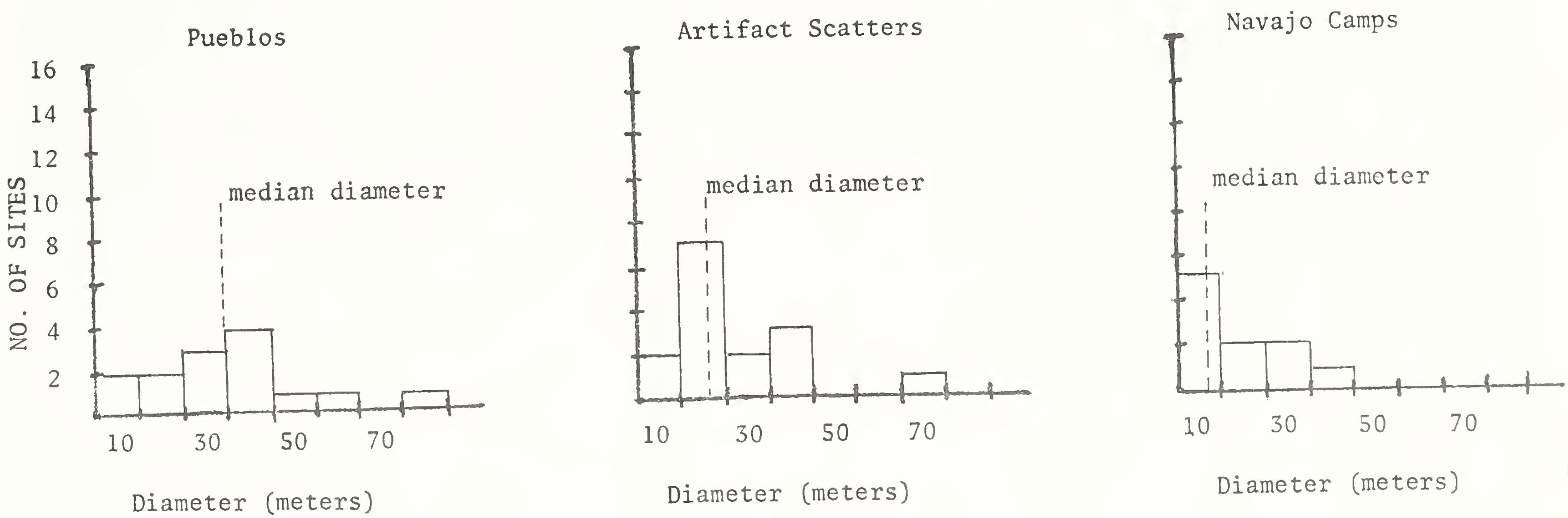

Figure 5. Comparison of Size Distributions for Three Categories of Sites. The great increase in numbers of artifact scatters in the 10-20 meter diameter range may reflect the presence of a survey-induced bias.

skewed towards the low range of values, and the survey has missed an undetermined number of sites which fell in the corridor between crew members. The other two categories of sites do not appear to reflect such a bias. The median diameter for pueblos is far greater than 16 meters, suggesting that only a small proportion of the pueblos would have been missed because of a small diameter. The situation with the Navajo camps is quite different, but again there does not appear to be a survey-induced bias. Very small diameter sites have been reported, with the maximum peak and the median diameter falling well below the 11 meter range.

The results are not overly surprising. Navajo camps observed during the survey all included the remains of some form of wooden structure which was noticable at a distance. The identification of Navajo camps did not depend on the direct observation of the surface. They could, in fact, be sighted fairly readily from a distance of 11 to 16 meters. With respect to Navajo camps, therefore, the space between surveyors was not a "blind" or unobserved corridor. Sherd and lithic scatters, on the other hand, can only be identified through the observation of artifacts on the surface. The space between surveyors represented an unobserved area in which sherd and lithic scatters could readily be missed.

To summarize, the survey practice of maintaining a distance of 15 to 20 meters between survey personnel results in a corridor 11 to 16 meters wide in which the ground surface cannot be directly observed. This corridor does not appear to have presented a bias in the indentification of masonry pueblos or Navajo camps. The former tend to have a median diameter which far exceeds the width of the corridor, and will thus be encountered by at least one crew member. The Navajo camps, on the other hand, tend to have structures which can be sighted from a distance, and they are thus identified even when they fall completely within the corridor.

The use of the 15 to 20 meter spacing interval between survey crews appears to have introduced a potential bias in the identification of only one type of site; sherd and lithic scatters. This is based on two considerations; 1) small sherd and lithic scatters are difficult to identify when they fall completely within the corridor between crew members, and 2) the average diameter of the observed sherd and lithic scatters is very close to the average width of the corridor. There is the potential that the number of small sites is greater than that which has been recorded by the survey.

Data Collection

A sample collection of surface artifacts was made from each of the prehistoric sites encountered during the survey. In general a stratified random sampling design was used, although variations were made to adjust to particular field conditions. The sites were also mapped.

Two different procedures were followed for making surface collections, depending on the size of the collection. If the site was relatively small and had distinct boundaries, a base line was laid out along its long axis and 20 x 20 meter quads were defined on both sides. Within each quad a 2 x 2 meter unit was then randomly selected for surface collection. This

resulted in a one percent stratified random collection of the surface material. Judgemental collections were also made from specific areas or features when it appeared that doing so would help increase the variability of the coverage. On occasion highly diagnostic artifacts such as projectile points or decorated sherds were collected and recorded by point provenience.

Sites which were large and tended to conform more to the boundaries of specific landforms were treated in a different way. Multiple base lines, oriented along the short axis of a site, were established at systematic intervals across the length of the site. A single row of 20 x 20 meter quads was defined along each side of each base line, and a random selection was made of a single 2 x 2 meter unit for surface collection. In effect, long sites were sampled through the use of several transects, each measuring 40 meters wide.

Summary

The survey provided coverage of about 1290 acres, or about one percent of the area covered by Tusayan Planning Sub-Unit No. 1 of the Kaibab National Forest, Arizona. It was conducted in three stages, each of which involved some variation in design. The type and extent of coverage provided by each stage is summarized as follows:

Stage 1: Stratified Random Sample/Transects

Sampling Unit: 1 mile x 50 yards; transect
Number of Units: 34
Area covered: 618 acres
Sampling fraction: .5%

Stage 2: Judgemental (Non-random) Sample/Transects

Sampling Unit: 1 mile x 50 yards; transect
Number of Units: 17
Area covered: 309 acres
Sampling fraction: .2%

Stage 3: Judgemental (Non-random) Sample/Quadrats

Sampling Unit: Quarter Quarter Section; quadrat
Number of Units: 3
Area covered: 365 acres
Sampling fraction: .3%

The following chapters present various analyses of the data obtained through the field work. Analysis of the ceramic material provides chronological control for some of the deposits. An attempt is made to characterize the functional variability of the sites through an analysis of lithic material.

CERAMIC ANALYSIS

The ceramic artifacts collected during the survey were typed and counted by Rick Effland, who also performed several computer studies in an attempt to identify stylistically sensitive groups of painted wares. The data compiled by Effland is presented in Table 6. The map in Figure 6 is also by Effland. Figures 7, 8, and 9 have been generated by Rice using the ceramic data in Table 6. This text is authored by Rice, and while he assumes responsibility for the interpretations and conclusions presented here, he gratefully acknowledges the useful criticism which Effland provided on an earlier draft and above all, the analytical effort which provided the basic data.

The map in Figure 6 shows the relative density of ceramic materials observed in the study area. The highest densities of sherds occur in the Upper Basin, and there are at least 25 sherds per transect over most of the basin. By contrast, ceramic density is very light in the Lower Plateau, and there are larger areas in which no ceramics were recorded at all.

Effland, in the preliminary report (Effland 1978), sought to address two problems in the ceramic analysis: that of establishing a chronology of the sites, and that of identifying a cultural boundary between the Kayenta Anasazi and Cohonina traditions. We will consider the question of chronology first.

Seriation is one of the most encompassing methods of dating sites when only surface collections are available. It is a unidimensional scaling technique which compares a series of sites (or other entities) on the basis of a set of classes (or variables) and ranks the sites into an order which satisfies the following condition:

> Starting from any arbitrarily selected site in the sequence, all other sites will become progressively less similar to it the further away they are in the sequence.

A successful seriation is not necessarily a chronology, but it is a major first step. In scientific studies, time is treated as a unidimensional phenomenon (it does not go backward, or branch off, or stop) so that if one is to claim that a series of sites are ranked chronologically, it is first necessary to demonstrate that the sites fit along a single dimension.

Additional hypotheses can also be tested (e.g., does the unidimensional ranking happen to be the product of spatial variation rather than temporal change?) to increase the confidence which the archeologist has in the seriation as a chronology (Dunnell 1970; Cowgill 1972).

Experimental studies have shown the effects of combining spatial and temporal variation (see Deetz and Dethlefsen 1965) or of including multi-period occupations with single-period occupations (See Dunnell 1970) in the same seriation. The effect of such non-chronological variation is easily seen in the shape of the frequency curves used to construct seriations. Instead of the ideal unimodal (or battleship) curve, the resulting curve will have multiple peaks or will form a concave rather than a convex pattern. This is especially true if items are being obtained through

Table 6. Frequency of Ceramic Types by Site or Collection Area.

	Tusayan/Moenkopi Corrugated	Tusayan Greywares	Lino/Kana'a B/W	Black Mesa/Sosi B/W	Dogoszhi B/W	Flagstaff B/W	Little Colorado B/W	Unknown B/W	Tsegi Orangewares	San Francisco Greywares*	San Juan Redwares	Deadman's B/G	Deadman's Fugitive Red	Floyd Greywares	Little Colorado Corrugated	Lino Grey	Other	TOTAL
13-1	5								3	3								11
18-1	72	22		6				1	1	16								118
18-2	235	49		35				16	5	123								463
19-1	99	61		6	6	3		7	4	6						8		200
20-1	1								1	36								38
21-1	3															14		17
22-1	10	7		8						34	1							60
26-1	20			2		1		1		9							1	
26-2	22	8		5				2		5								42
26-3	46	7		11				2	3	22								91
27-1	25	4		4			3	7	2	12	2	1	1	1				61
28-1	35	11		1	2	4			3								2	63
28-2	38									1	1		6		14			60
30-1	1			2					4									7
31-1	2	5		8				1	1	35			1					53
31-2	2							4		1								7
31-3	3	9	4	2				3		38	2		1					62
33-1	1	7								13								21
34-1	76	1				59	37	8	6	3	1				173			364
J-1	2	3								12								17
M-2	11									6								18
N-1	88	6	3	10	5	4	6	6	18	33	2	1						182
N-2	22	1		7	6													36
O-1	39	26		64				23	13	29	5							196
O-2		1	1							14								16

*Deadman's Grey

Table 6. (Cont'd).

	Tusayan/Moenkopi Corrugated	Tusayan Greywares	Lino/Kana'a B/W	Black Mesa/Sosi B/W	Dogoszhi B/W	Flagstaff B/W	Little Colorado B/W	Unknown B/W	Tsegi Orangewares	San Francisco Greywares*	San Juan Redwares	Deadman's B/G	Deadman's Fugitive Red	Floyd Greywares	Little Colorado Corrugated	Lino Grey	Other	TOTAL
0-3		7		1							8							16
P-1	17	36		12	1			1	1	10			1					79
P-2	95			16					6		3							120
QA-1	65	138	12	46	1		1	18	13	266	37	2	14	2				615

*Deadman's Grey

FIGURE 6. Density of ceramic material. Data points are represented by transects. An ordinal scale is ploted: (1) 0-25, (2) 26-50 (3) 51-100, and (4) 101=. The computer program is SYMAP

```
FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1          2          3          4
            ========================================
             .........  +++++++++  000000000  █████████
             .........  +++++++++  000000000  █████████
 SYMBOLS     ....1....  ++++2++++  000030000  ████4████
             .........  +++++++++  000000000  █████████
             .........  +++++++++  000000000  █████████
            ========================================
 FREQ.          20         12          8         10
          1  I..1..I    I++2++I    I00300I    I██4██I
          2  I..1..I    I++2++I    I00300I    I██4██I
          3  I..1..I    I++2++I    I00300I    I██4██I
          4  I..1..I    I++2++I    I00300I    I██4██I
          5  I..1..I    I++2++I    I00300I    I██4██I
          6  I..1..I    I++2++I    I00300I    I██4██I
          7  I..1..I    I++2++I    I00300I    I██4██I
          8  I..1..I    I++2++I    I00300I    I██4██I
          9  I..1..I    I++2++I               I██4██I
         10  I..1..I    I++2++I               I██4██I
         11  I..1..I    I++2++I
         12  I..1..I    I++2++I
         13  I..1..I
         14  I..1..I
         15  I..1..I
         16  I..1..I
         17  I..1..I
         18  I..1..I
         19  I..1..I
         20  I..1..I
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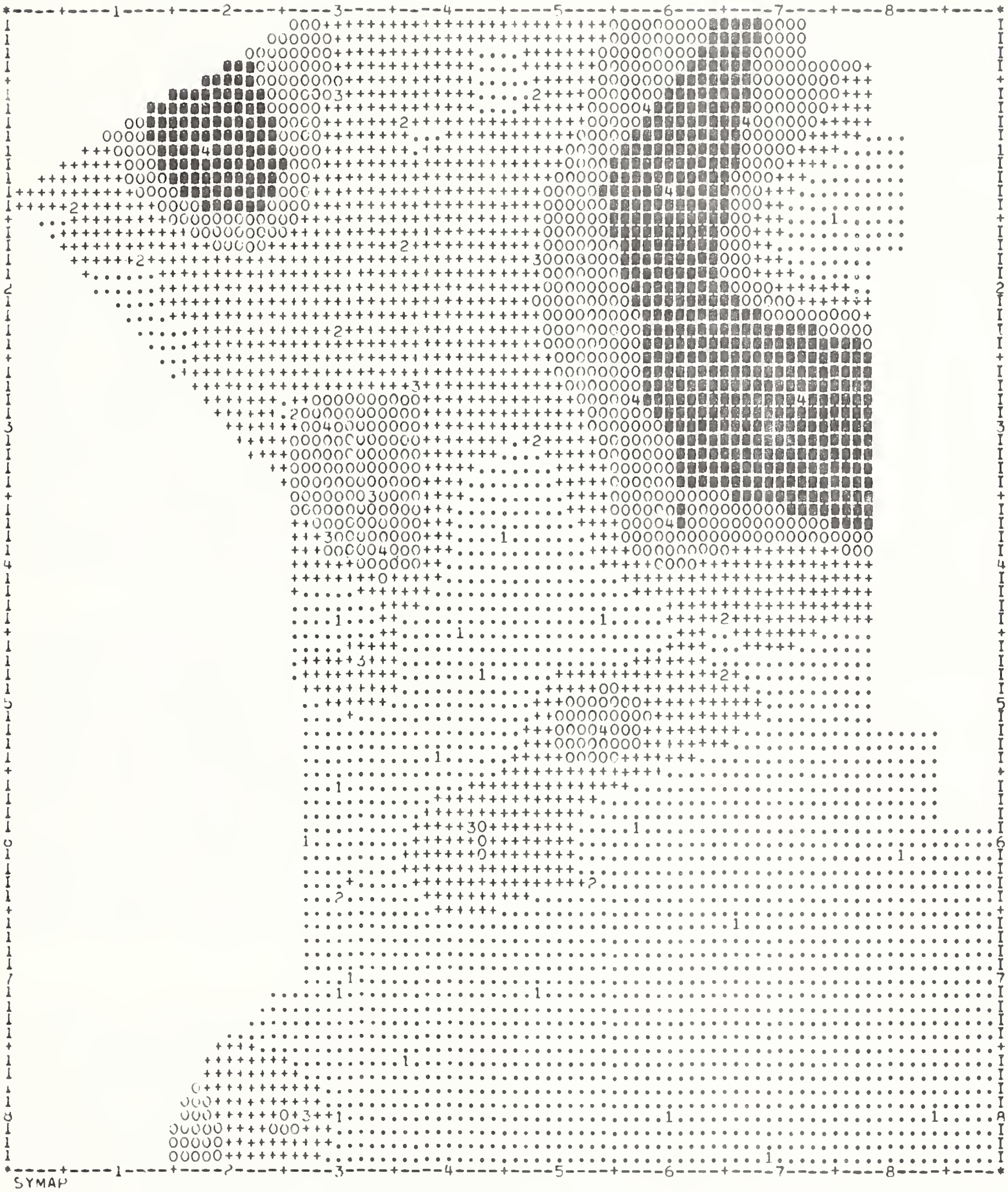
Figure 6 (cont.)



trade, and there are changes in the main production centers or trade routes. These experimental studies provide us with a method of evaluating seriations. Those which have the fewest and least glaring departures from a unimodal curve are the most likely to record only temporal (as opposed to a combination of temporal and spatial) variation.

Figure 7 shows one attempt to seriate the ceramic sites in the study area. Because of the possibility that both Cohonina and Kayenta occupations are represented in the sample, the traditional types were ignored for a more general set of characteristics. The seriation shows that plain grey wares decreased through time as various corrugated varieties increased. Black-on-white painted wares are, with a few exceptions, relatively constant in the 10 percent to 20 percent range.

This is not a very good seriation. First, the sites are being discriminated on the basis of primarily two variables (corrugated and plain wares), and it is always possible to get a solution when only two variables are involved. Second, there are major breaks in the shapes of the curves, resulting in multiple local peaks and valleys. This is the sort of pattern which occurs when trade wares are included in a seriation of local materials (see Deetz and Dethlefsen 1965). In fact, the irregularities in either the corrugated or plain ware curves are always associated with a compensating irregularity in the black-on-white pottery. This suggests that the black-on-white ceramics are being introduced from other areas, and that there are periods of greater and lesser accessibility to trade contacts. The decline of a particular style of black-on-white pottery could be attributed to one of two factors: either the style decreased in popularity, or the trade connections shifted to other locations.

Despite these shortcomings, it is plausible to treat the seriation as a chronology. The first reason is that the shift toward increased corrugated styles through time at the expense of plain wares is well documented throughout the Southwest. This seriation is consistent with that general chronological trend. The second reason is based on the information provided in Figure 8. In this chart the sites have been arranged in the order provided by Figure 7, and the presence or absence of various decorated styles has been recorded. Early styles of black-on-white, such as Lino and Kana'a, tend to occur at the top while late styles, such as Dogszhi, tend to occur at the bottom of the sequence. (The considerable overlap of styles suggests that occupations of the sites were fairly contemporaneous and of long duration.)

Effland has pursued a similar approach by attempting to date a sub-set of the sites by using the range of decorated wares which occur at each. Approximate dates for the duration of each style have been obtained from Breternitz (1966) and from Euler (personal communication). The results of the analysis are summarized in Figure 9. There is a general correspondence between this sequence and that obtained from the seriation, with two major exceptions. Site P-1 falls very easily in the seriation, in a position contemporaneous with QA-1 and 27-1. The seriation thus suggests a date in the eleventh rather than the twelfth century. Conversely, site P-2 occurs very late in the seriation, appearing to be roughly contemporaneous with site 34-1 which dates to the late twelfth or early thirteenth century. This suggests that both the relative and absolute attempts at chronology should be treated as generally but not specifically correct. The discrepancies in dating are attributable to low sample size and to sampling error.

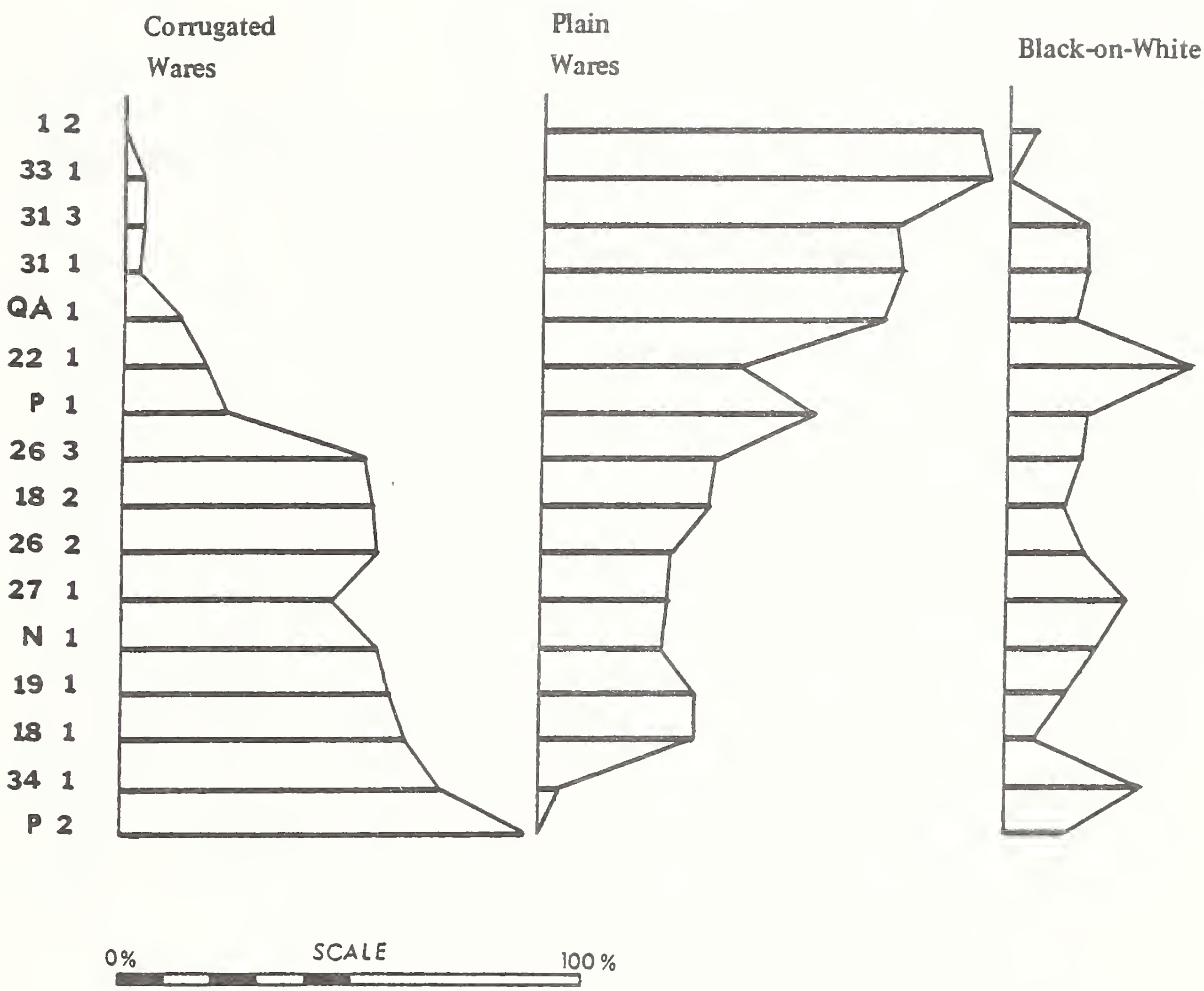
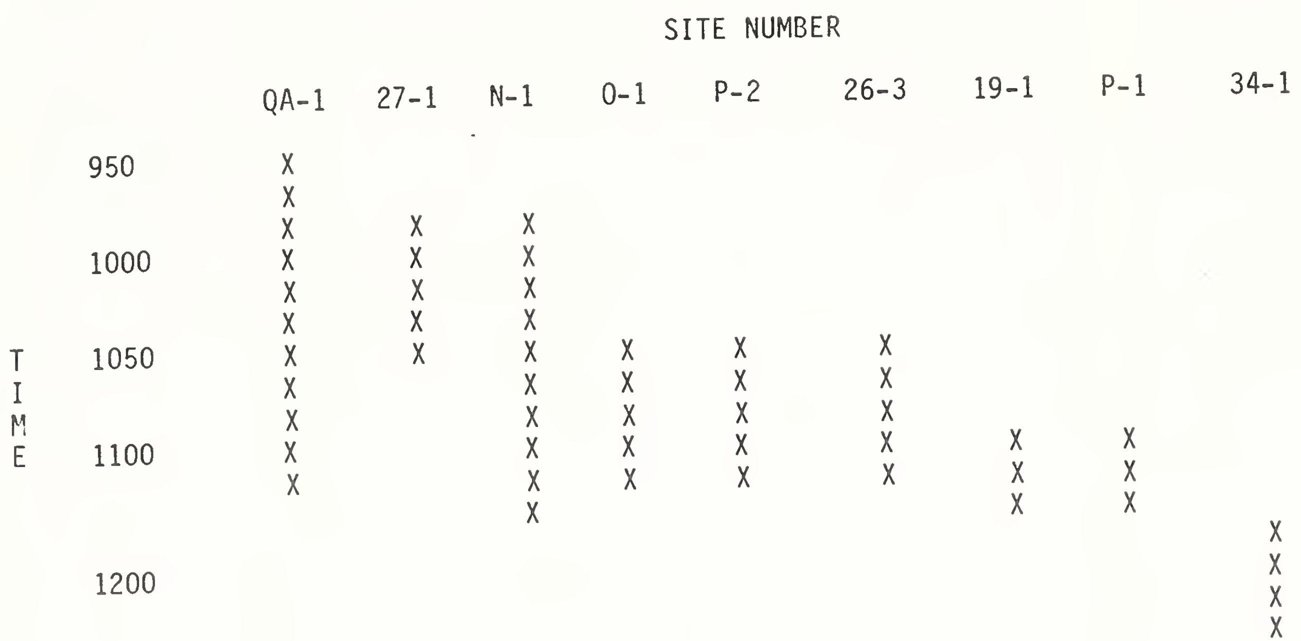


Figure 7. Frequency Seriation of Sites. Several components have been excluded because of low artifact numbers, and one Component (-) has been excluded because of an inordinately high bias towards decorated wares.

SITES	BLACK-ON-WHITE				OTHER	
	Lino and Kana'a	Black Mesa and Sosi	Dogoszhi	Flagstaff	San Juan Red Wares	Tsegi Orange Wares
0-2	X					
33-1		X				
31-3	X	X			X	
31-1						X
QA-1	X	X	X		X	X
22-1		X				X
P-1		X	X			X
26-3		X				X
18-2		X				X
26-2		X				
27-1		X			X	X
N-1	X	X	X	X	X	X
19-1		X	X		X	
18-1		X				X
34-1				X	X	X
P-2		X			X	X

Figure 8. Occurrence Seriation using Decorated Wares.

Figure 9. Dating of Several Sites Based on Decorated Ceramics. Dates are assigned on the basis of Breternitz (1966) and Euler (personal communications).



Given that there is some validity in accepting this ordering of sites as a chronology, it is used next to examine the question of identifying the boundary between the Kayenta branch of the Anasazi and the Cohonina branch of the Patayan. Effland feels that only a few of the occupations can be attributed to a Cohonina use of the area. This conclusion is based on the high frequency of Tusayan Whitewares (Sosi Black-on-white, Dogozshi Black-on-white, and Flagstaff Black-on-white) which are defined by Colton and Hargrave (1937:203) as the common service type of the Kayenta branch.

An examination of Figure 10 demonstrates that the non-decorated wares are divided between Kayenta and Cohonina of the Kayenta branch of the Anasazi. The plainwares include both Kayenta (Tusayan Grey) and Cohonina (San Francisco Grey) styles, but the former is, with a few exceptions, nearly always less than 20 percent. It is the San Francisco Greyware which shows the greatest amount of response to the gradual increase in Tusayan Moenkopi Corrugated.

The Tusayan wares are manufactured by the coil-and-scrape technique while the San Francisco Greywares (in this case, primarily Deadman's Greyware) are paddle-and-anvil. Their complementary interaction in Figure 10 is particularly interesting, therefore, since it suggests a major shift in ceramic technology. Inspection of Figure 10 shows that a relatively rapid drop in paddle-and-anvil wares (with corresponding jump in coil-and-scrape wares) occurs between sites 22-1 and P-1. This change is correlated, to a degree, with the appearance of masonry architecture.

The first three sites in the seriation (0-2, 33-1, 31-3) are sherd and lithic scatters. The fourth site, 31-1, is reported to have several walls, but they did not form enclosed spaces and Rice feels that the identification is dubious. Only sites QA-1 and 22-1 have both large amounts of paddle-and-anvil pottery and masonry architecture. (Of the remaining sites in the sequence in Figure 10, only 18-2 and 18-1 do not have definite masonry structures.)

This suggests to both authors that the prehistoric residents of the study area were initially participants in the Cohonina cultural tradition, but later became involved in an interaction sphere with the Kayenta Anasazi which led to several major changes in the architecture and ceramic technology. At a still later time, that interaction sphere changed or expanded to include contacts with the Little Colorado ceramic tradition, as is evident at site 34-1.

Further research is needed before the meaning of these findings can be evaluated. Is there a basic Cohonina cultural tradition which in some places took on an Anasazi veneer, or do we have a major developmental split in the Cohonina tradition, with one group becoming systemically and culturally Anasazi while the other group tended more toward the Patayan? Whatever the answer, it seems that if archeologists are to identify a boundary between the Kayenta and Cohonina traditions, they will have to deal with a phenomenon which shifts through time.

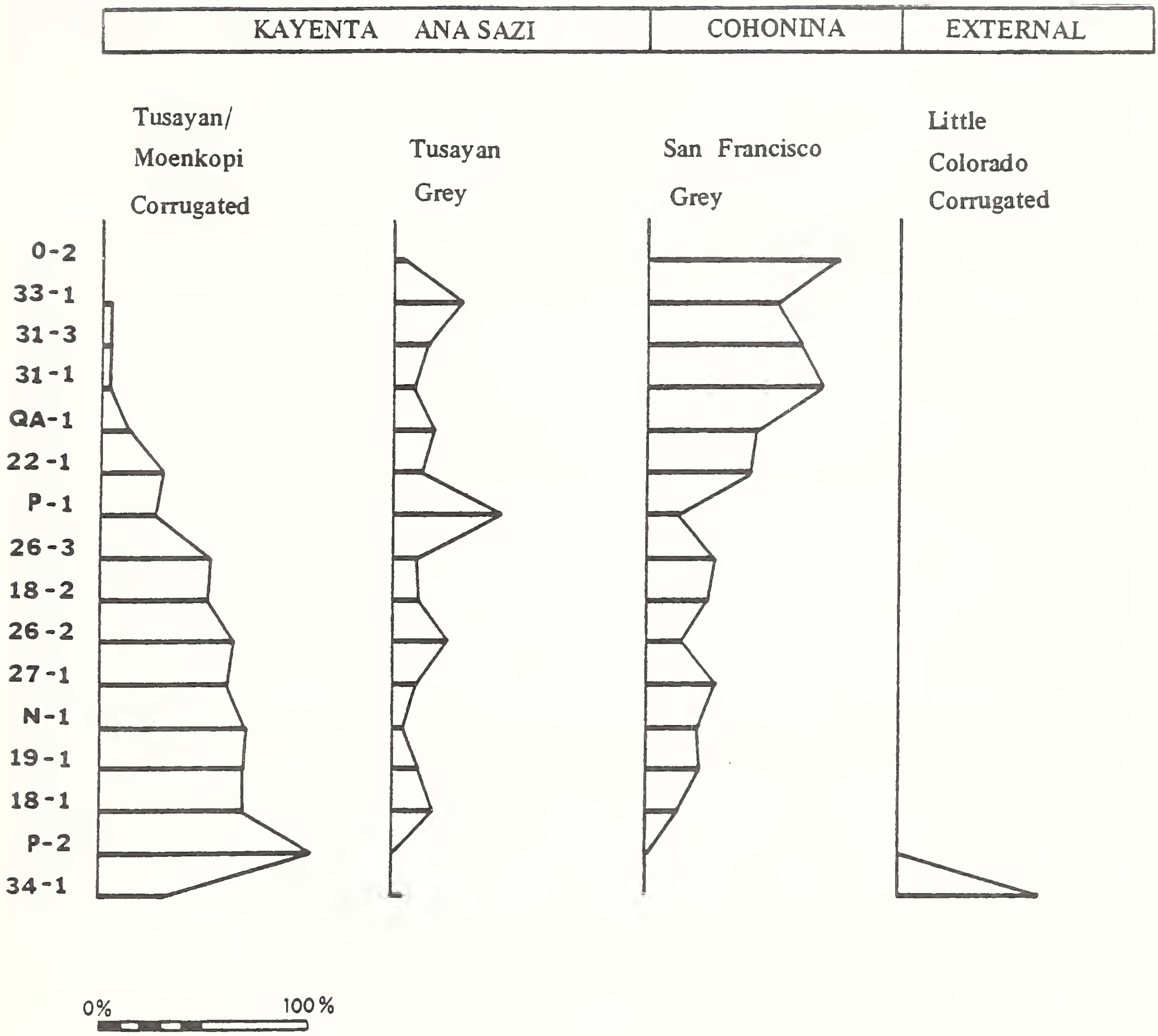


Figure 10. Frequency Comparison of Kayenta and Cohonina Ceramic Wares.

The ceramic analysis has resulted in a tentative ordering of sites in the Tusayan Planning Unit. It has also demonstrated that the local ceramic tradition is comprised primarily of Kayenta Anasazi styles, although there is an early dominance of Cohonina styles. The area appears to have been transitional between the Anasazi and Patayan ceramic traditions, and to have shifted interaction spheres from an early relationship with the west to a later tie with the plateau to the east. This shift in interaction spheres may well be related to the development of increasingly complex social systems among the Anasazi.

LITHIC ANALYSIS

A total of 2600 lithic artifacts were collected from sites in the Tusayan study area, with an overall coverage of 57 lithics per site. The artifacts were analyzed initially by Sherri Lerner, who recorded technological attributes, wear patterns, and raw material types. Several computer analyses were performed, but these proved to be largely unproductive. Since more than 50 percent of the sites are represented by less than 30 lithic artifacts each, this lack of success is not surprising and is directly attributable to small sample sizes. In order to overcome this problem, the sites have been organized into categories related to topography and site type, and the lithic materials have been compared between categories rather than between individual sites. The raw data have been compiled from the computer printouts by Laurie Blank, and are presented in Table 7.

The density of lithic artifacts per transect is shown by the map in Figure 11. There are relatively heavy concentrations of lithic materials in the northern portion of the planning sub-unit and several other high density areas occur both below and above the Coconino Rim. Additionally, the lowest density area occurs in the southeast portion of the planning sub-unit, in direct association with the more open grassland vegetation.

Slightly more than 78 percent of the chipped stone material was either debitage or chunks, with the remaining 22 percent consisting of material which had been modified or used in some way. The majority of macro-wear is in the form of nibbling. The only class of formalized tools which appear in high frequency are projectile points. The survey encountered 62 identifiable points and knives were found in isolated contexts. They do not vary greatly in style from those described by Jennings (1971) and James (1977), and appear to represent a lengthy occupation and use of the area from Archaic through Pueblo III times with a possible indication of a protohistoric occupation.

Table 8 provides a comparison of the use of raw materials between sites in the Upper Basin and Lower Plateau. In both areas chert is the most common material used, followed by quartzite and quartz. Obsidian, limestone, and basalt are used in considerably lower frequencies. There are no major differences in the use of raw materials between these two portions of the study area.

Projectile Points

The investigation of the lithic material in this section will proceed along two lines. The first involves a treatment of the stylistic variability of the projectile points for chronological purposes, and the second is a consideration of technological variables as a means of identifying variations in the activities performed at different locations.

There is one major limitation to this study of projectile points as temporal indicators, and that is that most were found as isolated artifacts rather than in the context of site deposits. There are 11 sites with

Figure 11. Density of lithic material. Data points are represented by transects. An ordinal scale is plotted: (1) 0-25, (2) 26-50, (3) 51-100, (4) 101-250 (5) 251-500, and (6) 501+. The computer program used is SYMAP.

```
FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1          2          3          4          5          6
          ================================================================
           .........  +++++++++  XXXXXXXXX  ΘΘΘΘΘΘΘΘΘ  ØØØØØØØØØ  █████████
           .........  +++++++++  XXXXXXXXX  ΘΘΘΘΘΘΘΘΘ  ØØØØØØØØØ  █████████
 SYMBOLS   ....1....  ++++2++++  XXXX3XXXX  ΘΘΘΘ4ΘΘΘΘ  ØØØØ5ØØØØ  ████6████
           .........  +++++++++  XXXXXXXXX  ΘΘΘΘΘΘΘΘΘ  ØØØØØØØØØ  █████████
           .........  +++++++++  XXXXXXXXX  ΘΘΘΘΘΘΘΘΘ  ØØØØØØØØØ  █████████
          ================================================================
 FREQ.          2          13         16         8          6          5
        1   I..1..I    I++2++I    IXX3XXI    IΘΘ4ΘΘI    IØØ5ØØI    I██6██I
        2   I..1..I    I++2++I    IXX3XXI    IΘΘ4ΘΘI    IØØ5ØØI    I██6██I
        3              I++2++I    IXX3XXI    IΘΘ4ΘΘI    IØØ5ØØI    I██6██I
        4              I++2++I    IXX3XXI    IΘΘ4ΘΘI    IØØ5ØØI    I██6██I
        5              I++2++I    IXX3XXI    IΘΘ4ΘΘI    IØØ5ØØI    I██6██I
        6              I++2++I    IXX3XXI    IΘΘ4ΘΘI    IØØ5ØØI
        7              I++2++I    IXX3XXI    IΘΘ4ΘΘI
        8              I++2++I    IXX3XXI    IΘΘ4ΘΘI
        9              I++2++I    IXX3XXI
       10              I++2++I    IXX3XXI
       11              I++2++I    IXX3XXI
       12              I++2++I    IXX3XXI
       13              I++2++I    IXX3XXI
       14                         IXX3XXI
       15                         IXX3XXI
       16                         IXX3XXI
```

Figure 11 (cont'd)

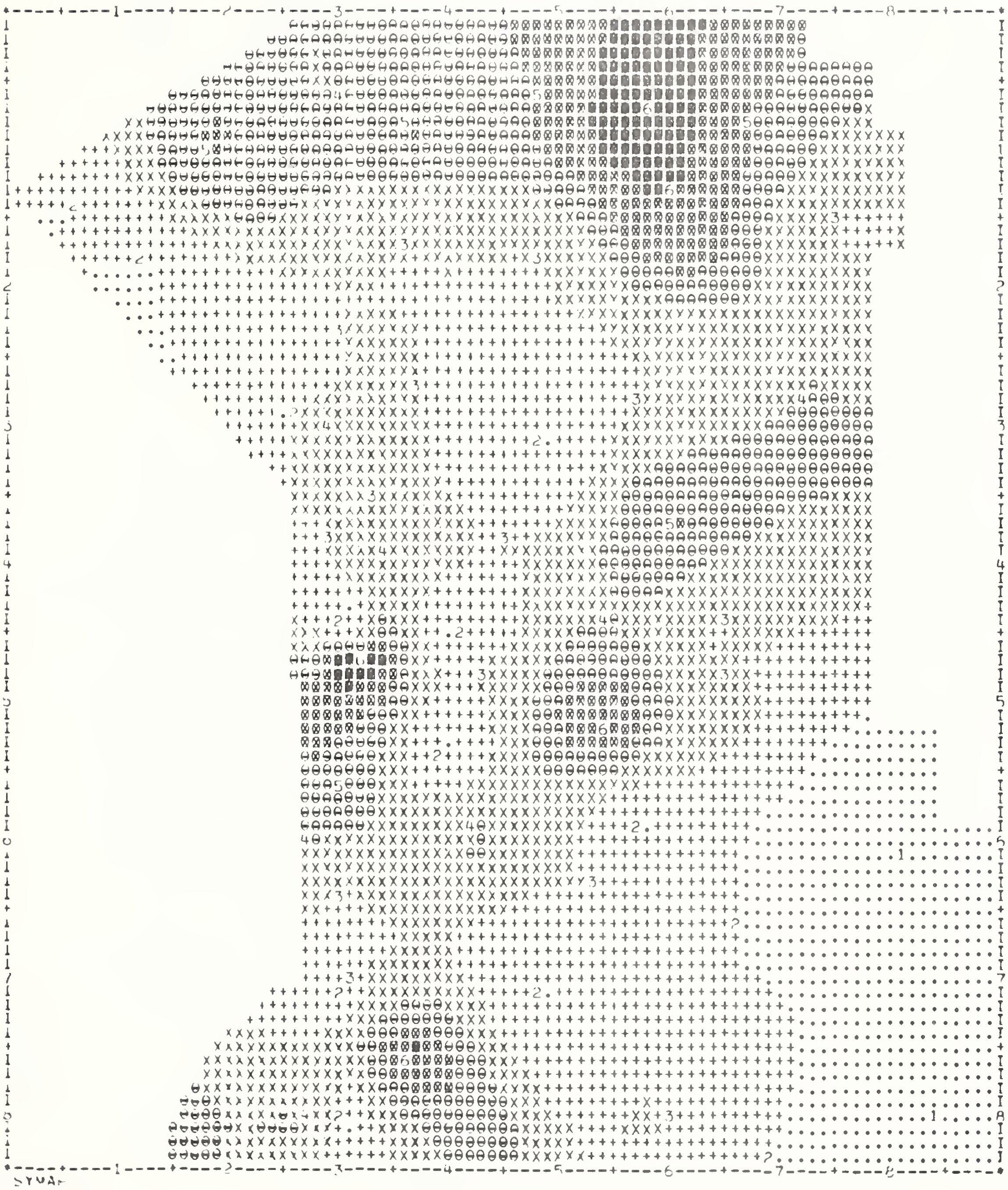


Table 7. Tabulation of Lithic Materials Recovered from Sites in the Tusayan Study Area.

Site Number	Number of Lithics	Used Flakes	Primary Flakes	Secondary Flakes	Tertiary Flakes	Cores	Ground Stone	Bifaces	Projectile Points	Other
1-1	41	6	4	3	32	1				
2-1	16	4	1		14	1			1	
7-1	342	16	40	95	196	11				
9-1	14	2			14					
12-2	28	9	3	3	16				2	
13-1	14	3	3	3	8					
14-1	285	10	7	8	270					
15-2 & 15-3	65	7	3	4	58					
18-1	211	15	14	24	172	1			1	
18-2	203	22	5	29	168	1			1	
19-1	61	13		5	55				2	
19-2	10	1	4	1	5					
20-1	55	7	2	12	39			2		
21-1	168	6	2	2	164					
21-2	90	5	7	2	78	2				
22-1	71	7	5	10	56		1		1	
25-1	3	1	1	1	1					
26-1	39	1	1	13	24	1				
26-2	10	5	2	1	7					
26-3	49	1		5	41					
27-1	10			2	8					
28-1	29	3	4	7	18					
30-1	5			1	4					
31-3	9	2		3	7					
31-2	3			1	2					
31-3	6	1		1	5					
33-1	20	5	1	4	15					
34-1	41	3	5	3	33					
J-1	26			4	21	1				
K-1	244	23	2	15	226	1				
M-2	15	1	1	1	13					
N-1	30	1	1	4	18			2		5 chunks
N-2	14			1	13					
O-1	55	11		6	44			1		4 chunks
O-2	11	1		3	8					
O-3	45	2		5	40				1	
P-1	34		1	2	31					
P-2	28	4		3	21					4 chunks
QA-1	419	30	12	42	346	6	2	4	5	9 chunks
QB-1	12	5	1	4	4			3		
QD-2	31	10		5	21					6 chunks
QD-4	117	8		7	106					4 chunks
QD-6	13		2		10					1 chunk

Table 8. Comparison of the use of Material Types. (Only random transects were used in this comparison)

LOCATION	Chert	Quartzite	Obsidian	Limestone	Basalt	Other
Lower Plateau	84%	6%	5%	3%	1%	1%
Upper Basin	72%	18%	2%	-	4%	2%

projectile points, and only two of those sites have more than two points. In general, therefore, we are dating highly idiosyncratic events associated with the loss of a single projectile point, and in the few cases where we are dealing with depositional contexts we are not certain what affect the low sample size has on our interpretations. At the same time, there is little that we can do to test the validity of various projectile point styles as temporal indicators. There are clearly no stratigraphic controls, and we have not been able to construct a seriation based on projectile point styles which could then be compared to the ceramic seriation. For the chronological validity of the styles we have had to rely solely on reports of previous research conducted in the area. Table 9 provides a list of the definition of styles used in this study. The types are first divided into six general groups on the basis of the shape of the blade, after which they are further subdivided using the criteria of notching, presence of stem, and shape of base.

The Category I styles consist of points formed on small, triangular blades. The shapes of the blades frequently approach an equilateral triangle, i.e., they have a relatively broad base. Type Ia consists of simple straight based triangular points, as illustrated in Plate 1 (m-r). This style is typical of the Coconino tradition and is frequently found in PII through PIII contexts (Jennings 1971:481). Type Ib consists of a single point (Plate 1, e), and is of a style which has been ethnographically attributed to the Havasupai (Spier 1928:151, in Jennings 1971:488). The stemmed varieties of type Ic (Plate 1, b-d) and Id (Plate 1, a) are characteristic of later Sinagua sites (James 1977:15). Category I projectile points are all relatively late prehistoric styles associated with ceramic traditions, and some varieties of the style may carry over into a protohistoric period.

Category II projectile points are formed on large blades that approach the shape of an equilateral triangle. There is a considerable amount of variability within this category, and it is not likely that they were all in use contemporaneously. The two examples of type IIc (Plate 2d, e) have a decidedly asymetrical base which appears to have been intentional since neither is broken. In overall appearance they are quite different from types IIa (Plate 3a, d) and IIb (Plate 3b, c). Type IId (Plate 3, f-g) is somewhat poorly defined, and some examples of this style may simply be shorter versions of style IVb to be discussed below. Points of this general triangular style are associated with the Late Rose Spring phase in California (Lanning 1963) and in the Willow Beach phase (Schroeder 1961), both of which are contemporaneous with the Cohonina ceramic period (Jennings 1971:461).

Category III styles consist of very elongated isosceles shaped blades with no notching and a straight to slightly convex blade. They occur in two general sizes, as shown in Plate 1 (f-l). These styles of projectile points are diagnostic of the Coconino tradition (McGregor 1974:307).

Category IV points have the highest frequency of occurrence in the study area. They are large, isosceles shaped points which are either side or corner notched. The blade portion of the point frequently has nearly parallel sides at the base which only begin to converge towards the mid-section (Plate 4, j). This category of points grades into category II, as

Table 9. Definition of Projectile Point Styles

I. Small equilateral blades
   a) straight base, no notching
   b) concave base, notching
   c) stemmed base, no tangs
   d) stemmed base, tangs

II. Large, equilateral blades
   a) convex base, side notched
   b) straight base, side notched
   c) concave base, side notched
   d) straight base, corner notched
   3) broken base, corner notched

III. Very elongated isoceles blades
   a) very long, straight base
   b) short, straight base

IV. Isoceles blades, corner notched
   a) convex base, corner notched
   b) straight base, corner notched
   c) concave base, corner notched
   d) broken base, corner notched

   Isoceles blades, side notched
   e) straight base, side notched
   f) concave base (formerly IIIc), side notched

V. Laurel-leaf shaped blades
   a) expanding blade, concave base

VI. Archaic series (large stemmed)
   a) Pinto Basin - Pentagonal shaped, with traiangular blade as large as stem. Concave base on stem.

   b) Serrated version of Pinto Basin.

   c) Silver Lake - same shape as Pinto Basin except for Convex base on stem.

   d) Misc. broken pieces which appear to be stemmed but which do not fit the proportion for the Pinto Basin or Silver Lake styles.

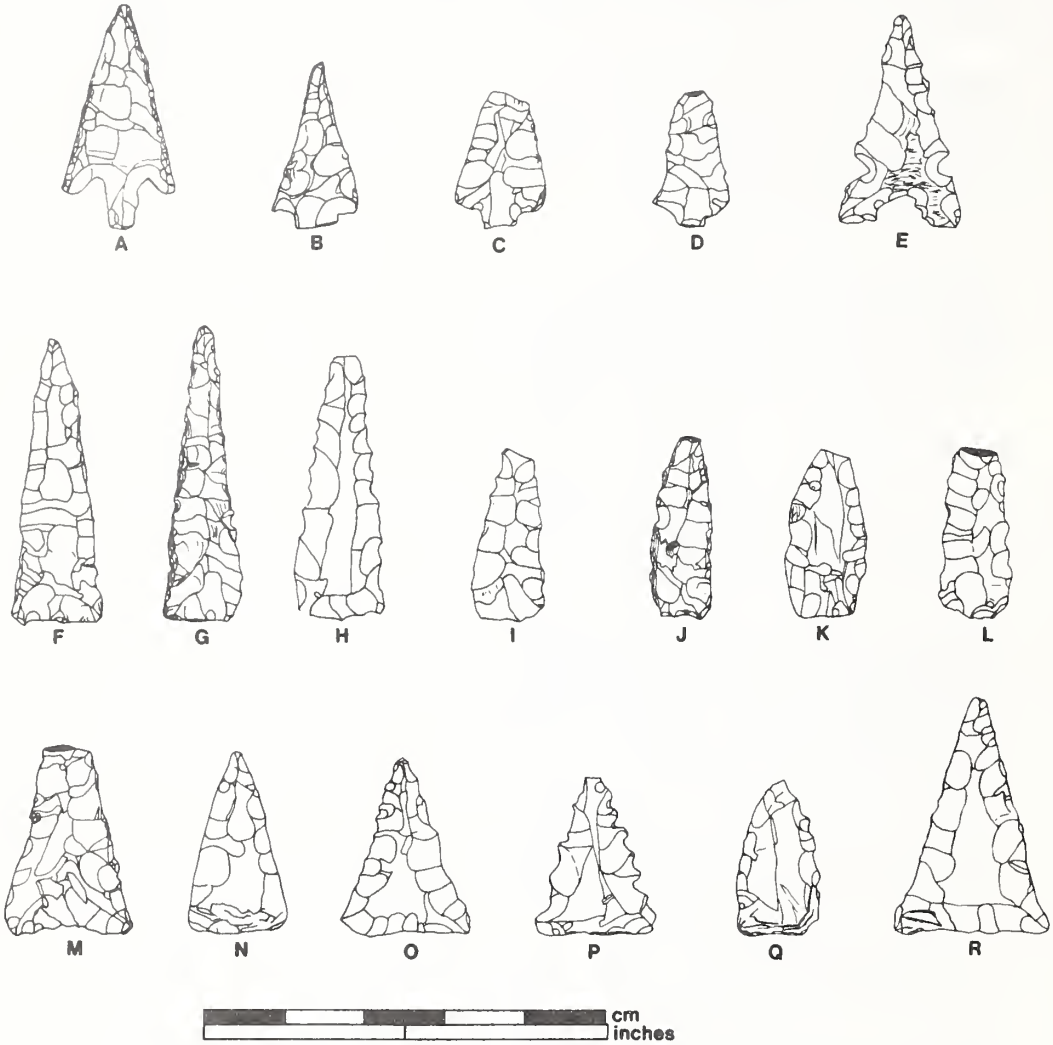


Plate 1. Tusayan Projectile Points.

PROVENIENCE KEY TO PLATE 1.

A - T24
B - B Ranch
C - B Ranch
D - T12
E - TO
F - T16-2
G - T12-2
H - T18-1
I - QL-1
J - B Ranch
K - T22-1
L - QA-1
M - T19-1
N - T26
O - T18-1
P - T26
Q - T16-2
R - QB-1

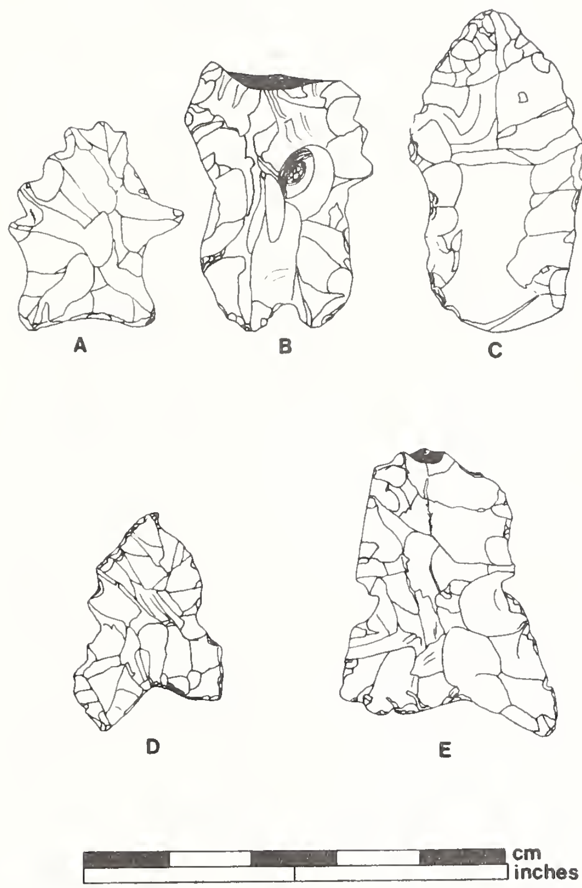


Plate 2. Tusayan Projectile Points.

PROVENIENCE KEY TO PLATE 2.

A - T14
B - TK
C - T2
D - T21
E - T18-2

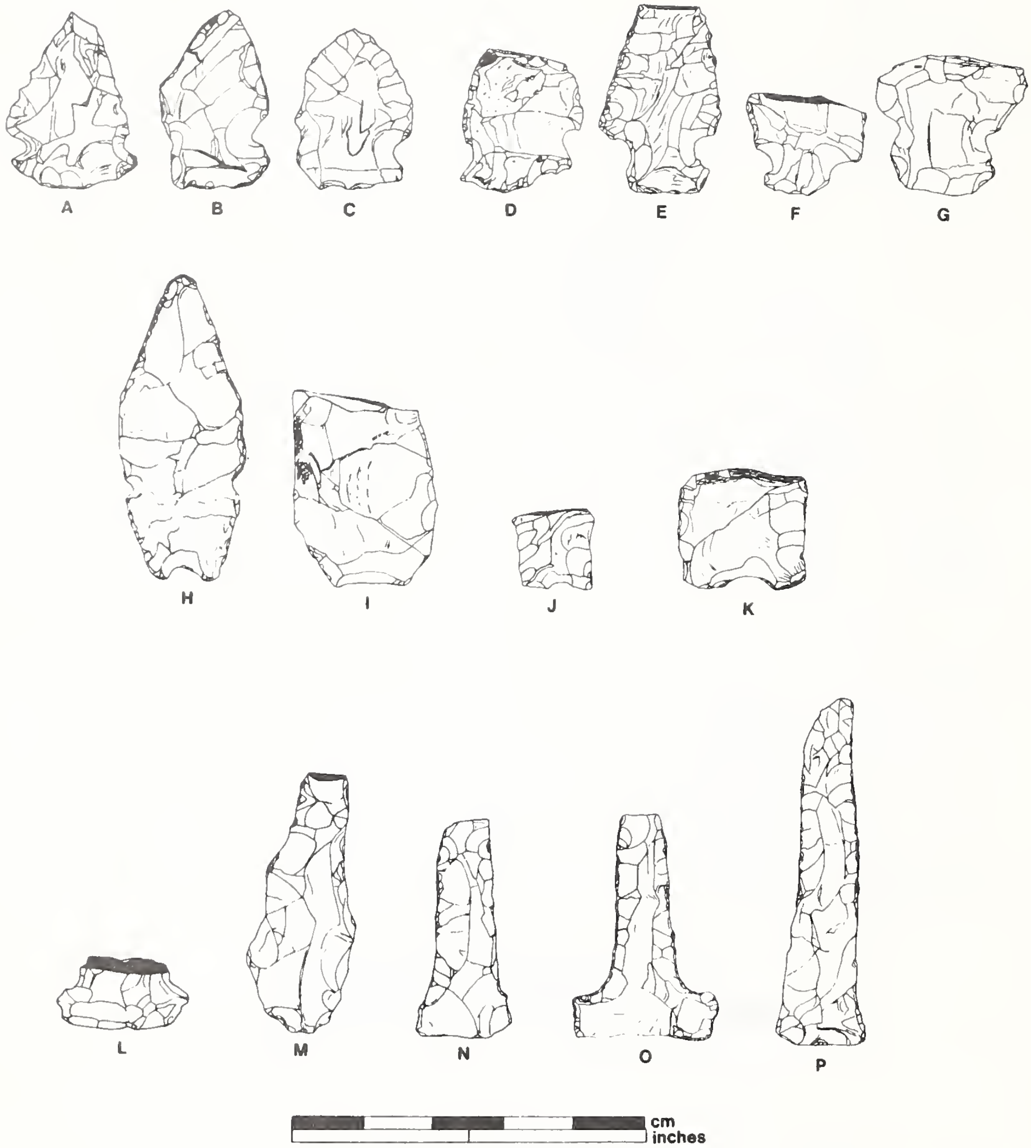


Plate 3. Tusayan Projectile Points.

PROVENIENCE KEY TO PLATE 3.

A - TO
B - T12-2
C - T3
D - uncertain
E - T21
F - T21
G - T29
H - Y14

I - TO
J - T13
K - T2
L - TH
M - B Ranch
N - B Ranch
O - TO-2
P - T2-1

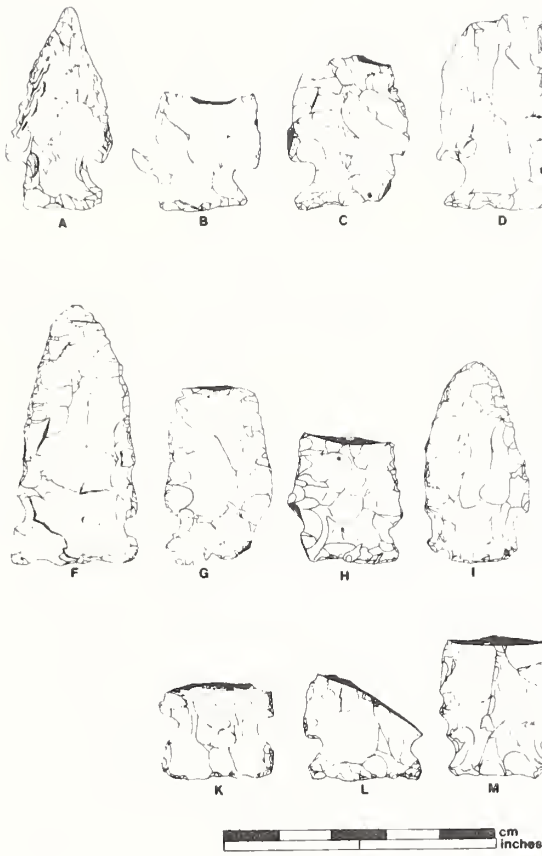


Plate 4. Tusayan Projectile Points.

PROVENIENCE KEY TO PLATE 4.

A - TK	H - TP
B - T24-1	I - T21
C - T27	J - T34-1
D - T29	K - TO
E - TO-3	L - TO
F - T13	M - QA-1
G - TA	

can be seen by contrasting point e in Plate 3 (Style IVe) to points a through d and f through g of the same plate. The side notched varieties (Type IVa through IVd) are illustrated by points f through i and k through m in Plate 4. The various types of corner notching are illustrated by points a through e and i in Plate 4. Points of this style have been reported from Harbison Cave occurring in both aceramic and ceramic horizons (Jennings 1971). Jennings (1971:470, 477), however, treats them as diagnostics for two of his Archaic phases (Red Horse and Hupmobile). James (1977:14) refers to these as styles which are typical of Basketmaker II and III. Nonetheless, both side notched and corner notched versions of Category IV points were found at three masonry pueblos and at a sherd and lithic scatter in the survey area. It appears, therefore, that their popularity was of long duration, encompassing the late Archaic as well as the Ceramic period.

Category V is comprised of laurel leaf shaped points with concave bases. Both examples of this style are shown in Plate 3 (h,i). The bases shown in j and k of Plate 3 may be from this type of point, but they could also be stems broken off from other styles, and we have treated them in the next category.

Category VI consists of Archaic/Paleo-Indian styles of projectile points (Wormington 1957:270). Two major types were found; Pinto Basin and Silver Lake. The Pinto Basin point is shown as b in Plate 2. A possible reworked version of a Pinto Basin point is shown in a of the same plate. Point c in Plate 2 is a Silver Lake point found at a lithic scatter on Transect 2. Two fragments which may be stems from Pinto Basin points are shown in Plate 3 (j, k), but this is a very dubious identification. In California, Silver Lake points are associated with the Lake Mojave phase which is part of the Paleo-Indian tradition (Willey 1966:54). The Pinto Basin style of projectile point is found in complexes which include grinding implements and are therefore part of the Desert Archaic tradition (Willey 1966:57-58). Stemmed styles of projectile points similar to Pinto Basin are associated with the Archaic tradition of Arizona, such as the Chiricahua Phase in southeastern Arizona, at Bat Cave in New Mexico, and at Ventana Cave (Willey 1966:58; Wormington 1957:179). In the Tusayan area, they are associated with the surface finds which McNutt and Euler (1966) have termed the Red Butte Phase.

Examples of large knives found in the study area are shown in Plate 5. A series of drills, with and without tangs, are shown in Plate 3 (l-p).

Table 10 provides a tabulation of the occurrence of identifiable styles in the study area. The points are enumerated either by site or by the transect unit in which they occur. The styles are organized in rough chronological order from the protohistoric (left) to the Paleo-Indian (right) period.

Inspection of the data in Table 10 suggested that there was some patterning in the relative occurrence of styles. In Table 11 we have enumerated the number of times different styles co-occur in the same provenience unit (either site or transect). Two sets of styles, Ia and those of Category

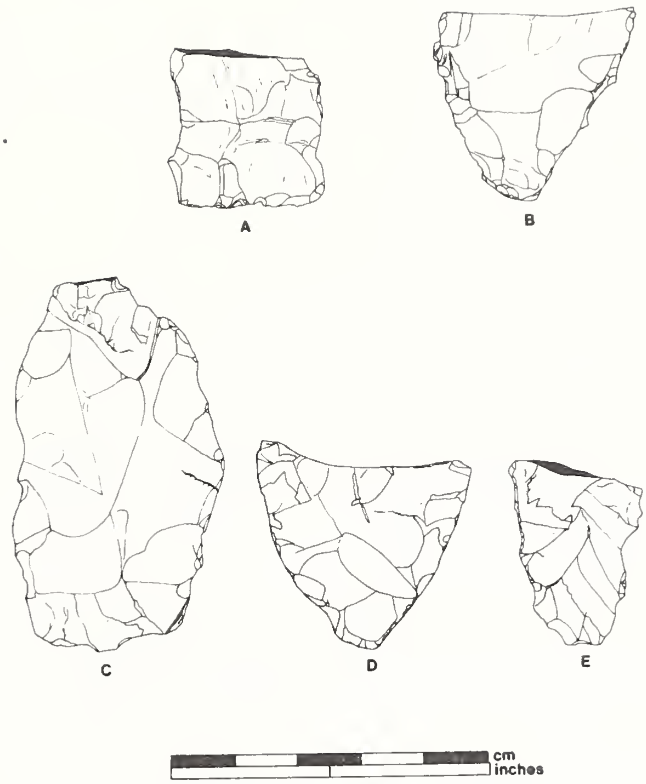


Plate 5. Tusayan Projectile Points.

PROVENIENCE KEY TO PLATE 5.

A - QA-1
B - location uncertain
C - T14
D - T14
E - T18

Table 10. Occurrence of Projectile Point Styles in the Tusayan Study Area

	I				II					V	III		IV						VI			
	a	b	c	d	a	b	c	d	e	a	a	b	a	b	c	d	e	f	a	b	c	d
T26	2																					
T19-1	2																					
QB	1																					
TD-3														1								
T15B		1								1							2					
B Ranch			2									1										
T12			1																			
T12-2					1						1											
T24-1														1								
T24				1	1																	
TN					1																	
T29					1									1			1					
T3					1																	
T21					1		1						1				2					
T18-1											1											
T18-2							1															
T18																		1				
QA-1								1	1					1	1		1					
T9								1								1						
T14									1	1												
TP									1								1					
TC-1														1								
TC									1													
T16											1	1										
T22																						1
T22-1												1										
TK														1								
T8														1								
T27															1							
T13																	1					
TA																	1					
T20																	1					
T34-1																	1					
TK																				1		
T13																				1		
T14																				1		
T2-1																					1	
T2																			1			1

Table 11. Co-occurrence Patterns Among Projectile Point Styles in the Tusayan Study Area.

	Styles						
	Ia	III	Ib-d	II	IV	V	VI
Ia	5	-	-	-	-	-	-
III	-	6	1	1	-	-	-
Ib-d	-	1	5	1	2	1	-
II	-	1	1	14	10	1	-
IV	-	-	1	7	23	1	-
V	-	-	1	1	2	2	-
VI	-	-	-	-	-	-	5

VI, never occur with other styles. The other styles partially overlap. Category III occurs with Category II and the rest of Category I (b through d), but not with Categories IV and V. Conversely, Categories IV and V occur with those of II and I (b through d) but not III.

The significance of this pattern is not currently interpretable. It may represent changes in land-use patterns through time, but this cannot be evaluated until we have better chronological controls on the age and relative duration of the styles. It is interesting to note, however, that all of the Pinto and Silver Lake points are restricted to the southern portion of the study area, in the areas which currently have greater expanses of grassland than woodland. These finds are all in the general vicinity of the local landmark known as Red Butte, around which McNutt and Euler (1966) found a series of early lithic sites.

Little more of an analytical nature can be said about the projectile points found in the study area. The main findings have been that:

1 - Early Pinto Basin and Silver Lake styles occur, but are limited to the southern portion of the study area.

2 - Side notched and corner notched points, previously thought to be principally of the Archaic and Basketmaker traditions, are shown to also occur readily in Puebloan contexts. Their utility as time markers is currently questionable.

3 - Small, isosceles shaped points with various types of bases may have utility as chronological markers for the late ceramic and protohistoric period.

4 - There are specific patterns of co-occurrence, as summarized in Table 11, which might reflect changing patterns of land use. Conversely, this could reflect functional variation, since the contrast is also between small and large styles of points.

Chipped and Ground Stone

The other aspect of this study has been the investigation of technological variability in an effort to identify differences in activities which are correlated with space. Figure 13 presents bar graphs comparing the frequency of primary, secondary and tertiary flakes and of cobbles and cores at different site types in the Upper Basin and the Lower Plateau. In almost all categories of sites, the frequency of technological types follows a very similar pattern, with tertiary flakes dominating the collection. There is one major exception. Site 7-1 is a lithic scatter in the Lower Plateau which appears to be a primary reduction site (and possibly appears to be a quarry). The material was almost 100 percent chert, and the frequency of primary and secondary flakes is closer to that of tertiary flakes. In addition, there is a relatively high number of cobbles, items which would have been useful as hammerstones.

Only three pieces of ground stone were collected during the survey. In addition, manos and/or metates were observed at sites QD-2 and QD-6. Table 12 presents the relevant descriptive information about each. This low frequency of ground stone is unusual. While ground stone has been recovered from excavated sites in the area, this survey observed extremely low frequencies. It has already been stated above that the subsistence base of the Tusayan population was, in large part, based on hunting and gathering of non-seed plant resources. Such a strategy would lead to a number of different kinds of specialized limited activity loci, a large number of projectile points, and a low density of ground stone. While agriculture was practiced to a degree, it may not have been very important.

Rice (1975) has suggested for another portion of the Southwest that Pueblo I and II populations may have been able to maintain a sedentary life while depending more on natural than on cultivated resources. By distributing the population across a number of different but neighboring microenvironments, it would have been possible to exchange resources to

Table 12. Ground Stone Collected in the Study Area.

Site No.	Type Mano	Material	Shape
QA-1	two-hand	quartzite	rectangular
QA-1	one-hand	sandstone	ovoid
22-1	one-hand	sandstone	ovoid

Ground stone objects were also observed at QD-2 and QD-6.

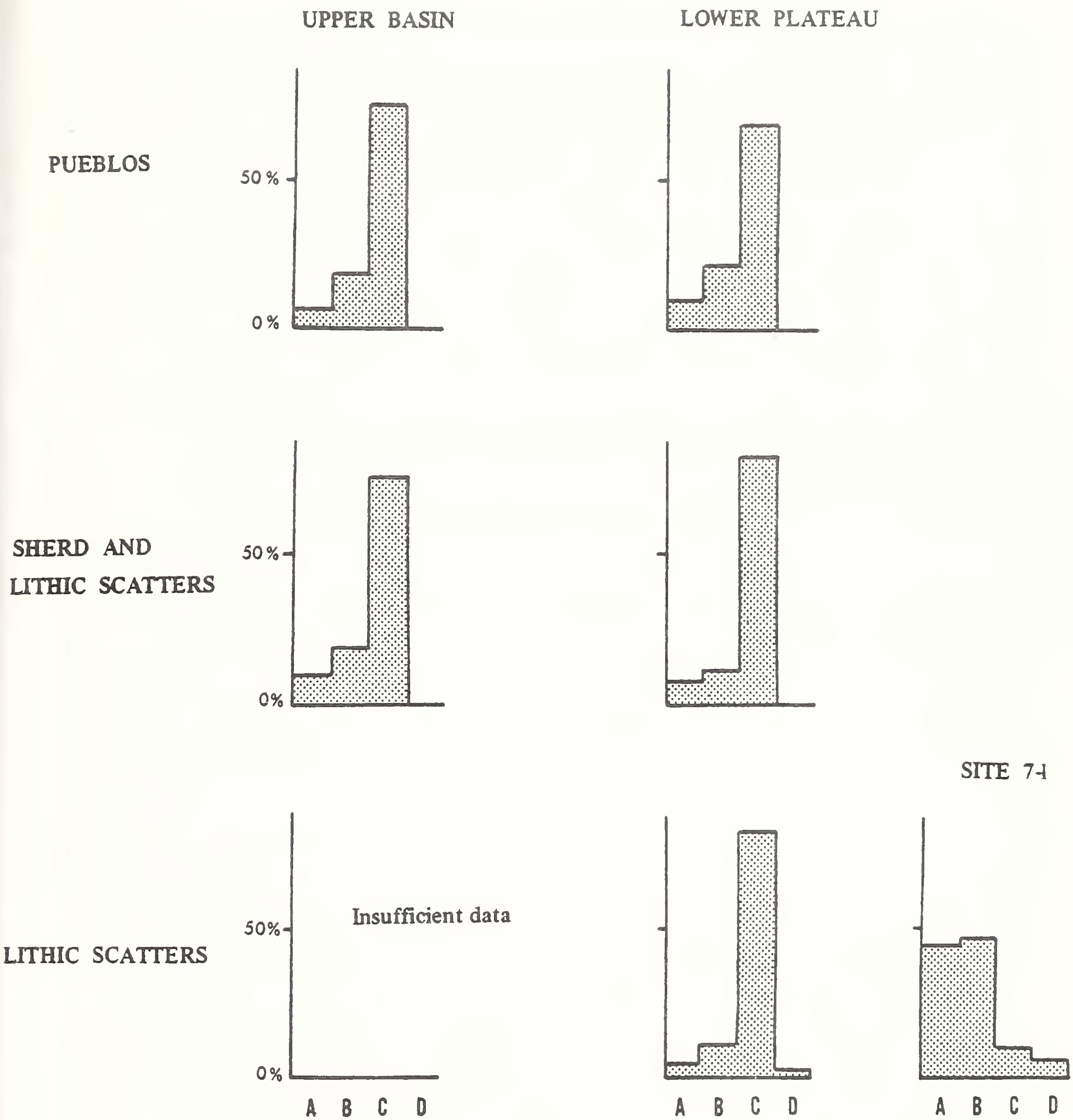


Figure 12. Technological Comparison of Site Categories. Only one site is significantly different from the others.

KEY: A = Primary Flakes B = Secondary Flakes
C = Tertiary Flakes D = Cores and Cobbles

balance out annual or seasonal shortages in any particular area. Under such a system, a high degree of diversity is preferable, which may account for the small size of Pueblo II occupations. By keeping the size of any single residential unit small, it would have been possible for the total population to occupy a greater range of microenvironments. If such a settlement and subsistency system characterizes the Puebloan occupation of the Tusayan area, it would account for the low incidence of ground stone. The use of agriculture may have been quite limited.

The analysis of the lithic material has shown the following:

1 - There are no differences in the use of material types bewteen the Upper Basin and the Lower Plateau.

2 - With one exception, there are few differences between site types on the basis of technological products. Most sites have a high frequency of tertiary flakes.

3 - One site (7-1) is clearly the locus of primary reduction of lithic raw material. It has high frequencies of primary and secondary flakes.

4 - The occurrence of lithic materials drops off in the grasslands towards the southeast corner of the study area.

5 - Overall, there is a very low frequency of ground stone in the artifact inventories of sites in the project area. This may reflect a low reliance on the use of cultigens and other seed-type foods.

One factor hampering the interpretation of the lithic analysis is the overall small sample size obtained from most sites. This could be rectified in future surveys by conducting more extensive collections from each site. The other alternative, however, is to forego any lithic analysis and include only ceramics in the collections which are made from the sites. This latter alternative is seen as more viable, since it would reduce the impact of the survey on the sites and would improve the efficiency of the survey.

TOWARDS A PREDICTIVE MODEL OF SETTLEMENT PATTERN DISTRIBUTIONS

Introduction

The 1 percent sample survey of Tusayan Planning Sub-Unit No. 1 has resulted in the identification of 26 masonry pueblos, 24 sherd and lithic scatters, 8 lithic scatters, 3 areas of isolated artifacts (termed non-site areas), and 16 Navajo camps. Because of the specific design of the survey it is possible to use this information to generate predictions and expectations concerning the overall distribution and patterning of sites within the study area. Such data on settlement patterns is useful for both management and research purposes. The variability within the sample is discussed first, followed by an explanation of two different methods for calculating site densities. Hypotheses concerning the correlation of settlement distributions to environmental factors are tested.

Variability Within The Resource

The archeological resources observed during the survey can be segregated into five categories: Navajo camps, prehistoric sites with architectural remains, sherd and lithic scatters, lithic scatters and areas of very light-density artifact scatters.

Navajo sites, of which 16 were located, range in size from 12 square meters to 900 square meters (areas were recorded for only 10 of these). These can be grouped into three general categories. The first are areas which contain at least one brush structure, a hearth and usually a light scatter of trash. A-2, C-1 and K-2 are examples of these sites. One site, A-1, contained five ramada structures and seven hearths. Presumably these are areas at which Navajo pinyon gatherers slept and prepared meals. These sites range in size from 48 square meters to 900 square meters with a mean size of 320.5 square meters. Figure 13 is a map illustrating the layout of such sites. A second category might be described as areas of short duration stays. Although more than one activity may have occurred at these sites, it appears that they were used for other than "home base" areas. These include small, wooden "teepee-like" structures with hearths or piles of charred rocks which were used as sweat lodges. Also in this category are shade structures and very small shelters. Three sites of this category were located and all measured 12 square meters, considerably smaller than the average campsite size. A final category consists of the more permanent, hogan structures. The considerable effort expended in building these structures would indicate that they were used for longer periods than the brush structures used during pinyon gathering. Only one hogan was located during the survey and it was accompanied by a sweat lodge. The entire site measured 600 square meters.

Twenty-six prehistoric sites with architectural remains have been located. Judging from the eroded surface remains, these range in size from 1 to 10+ rooms. The surface area of these sites, obtained by measuring the associated artifactual distribution, varies from 50 square meters to 5000 square meters. The majority of these sites contain rectangular rooms and are generally thought to be habitation sites. With a possible exception of the

10+ room pueblo (Q-1) these sites probably housed nuclear or small extended families. Two or more family units could have occupied Q-1. Site Q-2 is a circular 2-room structure which is either a pithouse or a kiva (a structure generally associated with religious practices but not with habitation) and site Q-1 has one surface and one subsurface room which may also be a pithouse or kiva. There appear to be three broad structural site types: small masonry pueblos, larger pueblos, and those sites which have either circular or subterranean structural units. The inference that these are habitation units is made solely on the basis of field judgements concerning architectural elements. Functional variability must also be accounted for through study of community patterns and artifactual remains. Temporal variability is another very important factor which has not been considered here.

Artifactual scatters are often considered to be the remains of specialized activities such as hunting, gathering, or the extraction of resources such as lithic material, which take place outside the habitation area. They can also be the remains of habitation sites in which evidence of architectural units has been destroyed. For these reasons, final judgement concerning the function of these sites must ultimately be reserved for a time when artifactual analysis has been performed and some excavation has been conducted. For the purposes of this study, therefore, I have grouped both lithic scatters and sherd and lithic scatters into one site category called artifact scatters.

These sites range in size from 54 square meters to 5000 square meters. Their sizes have been graphed (Figure 14) and display an interesting grouping. There appear to be two clusters of sizes; one below 300 square meters and one of large sites, with a broader range of 1600-5000 square meters. Three possible explanations can be offered for the apparent size differentiation: 1) because site size is thought to reflect the type of activity performed at a site, these may represent two functionally distinct site types; 2) repeated use of a general area would tend to result in a denser and somewhat larger scatter of artifacts so that the larger areas would represent more frequently utilized areas; and 3) differential post-depositional factors, i.e., slope wash, degree of animal traffic or partial burial of sites are responsible for the differences in site sizes. Testing these hypotheses is beyond the scope of this report.

One interesting trend was noted during a review of the characteristics of these two different-sized categories. Elevation and vegetation are similar between the groups but landform tends not to be. Table 13 lists the sites by size and on-site landform. A Chi Square Test was conducted using Yates continuity correction. As shown in Table 14, there is probably an association between landform type and site size. Tau B indicates that the strength of this association is .46, fairly strong. This probable association does not indicate which of the proposed theories is correct but does show that the distribution of smaller scatters on ridges and the larger sites on other landforms is probably part of a more general pattern. It lends credence to the idea that there are indeed two distinct site types. The explanation of this dichotomy rests in further research.

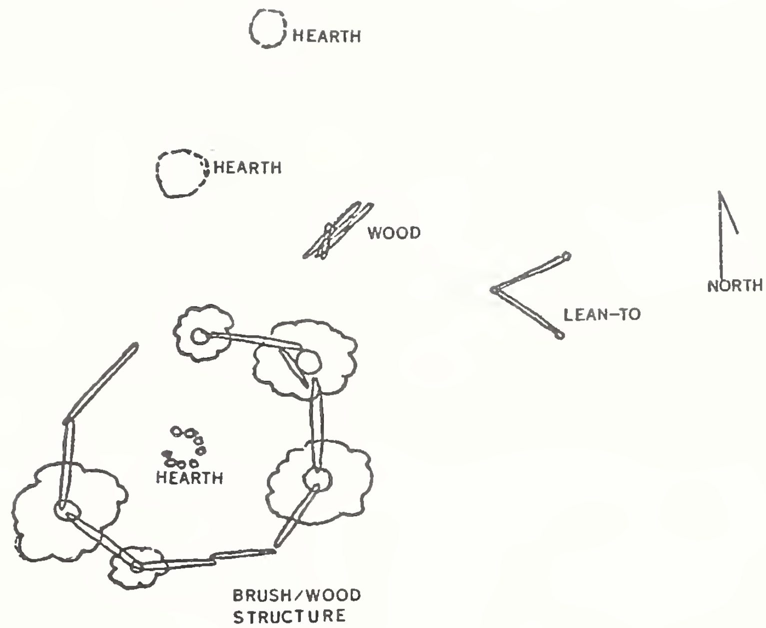


Figure 13. Typical Navajo Utility Site observed during the survey.

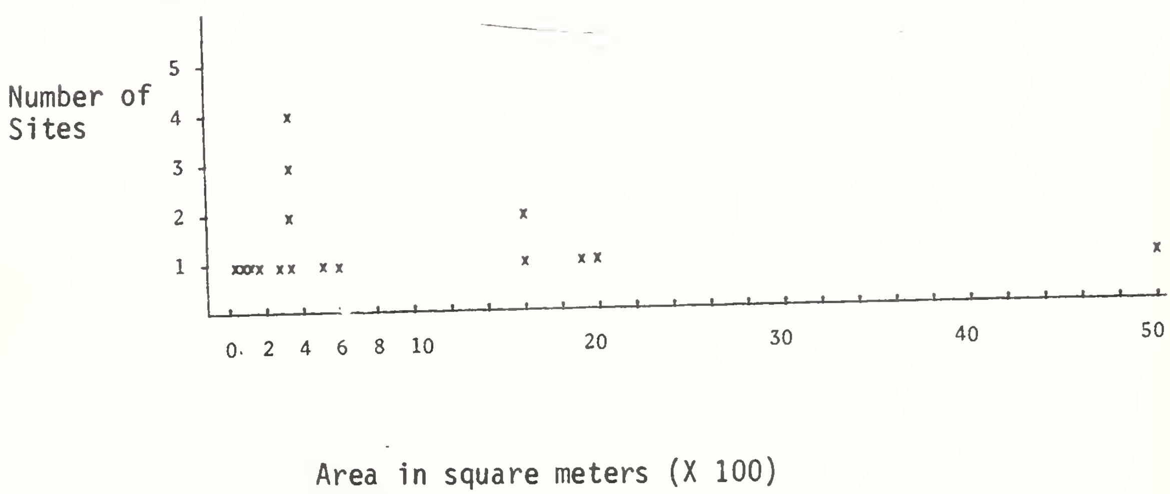


FIgure 14. Size Distribution of Sherd and Lithic and Lithic Scatters. (Includes only those sites for which it was possible to obtain a field estimate of area.)

Table 13. Artifact Scatters Compared by Size and Landform.

	Site #	Site size in m^2	On-Site Landform
Area less than 300 square meters	1-1	54	ridge
	12-2	300	ridge
	18-2	300	flat
	25-1	200	ridge
	28-1	250	ridge
	31-2	300	base of rim
	N-2	80	ridge
	P-1	120	ridge
	QD-6	116	ridge
Area greater than 1000 square meters	18-1	1776	flat
	26-1	5000	rock shelter
	26-2	1600	terrace
	28-2	1610	hillside
	QD-1	2000	ridge
Area between 300 and 1000 square meters	31-3	520	ridge
	0-2	600	ridge

The sites with an area less than 300 square meters tend to occur on ridges. Those less than 1000 square meters tend to occur on ridges. Those greater than 1000 square meters tend to occur on other landforms. Only sites with both landform and recorded areas could be used.

Table 14. Contingency table used for computing Chi square using Yates correction for continuity.

Land form	Size Range 0-300 m^2	Size Range 1600+ m^2	Total
Ridges	7	1	8
Other*	1	4	5
Totals	8	5	13

x^2 = .05 df = 1 x^2 (corrected) = 4.8779 Tau b = .46

*Includes rockshelters, terraces, hillsides and flats.

Calculation of Site Densities

One purpose of the survey is to develop predictions of site densities for the entire planning sub-unit and for zones within that sub-unit. Two different methods can be used to make such calculations. The first method involves dividing the number of sites in a particular zone by the number of transects in that zone and multiplying by a constant of 35.2. The constant represents the number of 1 mile long and 50 yard wide transects which fit into a square mile. The operation is summarized by the following formula:

$$\text{Site Density per square mile} = \frac{\text{No. of Sites (Zone}_i\text{)}}{\text{No. of Transects (Zone}_i\text{)}} \times 35.2$$

This method of calculation tends to inflate estimates of site density, however, because of a phenomenon known as the "boundary effect." In any situation where sampling units are employed, a site will be observed and recorded even if only a small portion of its area actually lies within the unit's limits. Thus, the survey of a sampling unit tends to also incorporate a secondary area around the boundary of the sampling unit which is related to the size of sites in a particular region. This boundary effect is accentuated in the use of transects because the ratio of the perimeter of the unit to the area within the unit is very high. The boundary effect

can be corrected for in the Puebloan areas of the American Southwest by using an empirically derived figure of 25 rather than 35.2 transects per square mile (Fred Plog, personal communication). This compensates for the overestimation resulting from the boundary effect. The formula for the corrected estimates of site density per square mile is as follows:

$$\text{Corrected Site Density per square mile} = \frac{\text{No. of Sites (Zone}_i\text{)}}{\text{No. of Transects (Zone}_i\text{)}} \times 25.0$$

Table 18 provides site density estimates (using the corrected formula) for different vegetation zones and for the Upper Basin and Lower Plateau. The total number of sites estimated for the study area is about 4300.

Distributional Analyses

Management of cultural resources demands a knowledge of the location of these resources. Recently, archeologists have begun to develop predictive models of site location based on environmental variables (Lightfoot and DeAtley 1977; Plog 1978; Lightfoot 1978; Lerner 1979). Environment has proven a useful guide to site locations because prehistoric populations, in their search for wild food and raw material sources, good agricultural land, and suitable habitation locations as well as the modern land use management people, are keyed into environmental variability. The variables of elevation, landform, and vegetation were examined in developing a predictive model of site location for the Tusayan Planning Unit. Both prehistoric and modern aboriginal use patterns are considered. Further study of the archeological resources and the use of greater control in the recording of environmental variables than has been utilized here (particularly landform and vegetation) might permit the development of both more sophisticated and more accurate models.

Management and research decisions concerning cultural resources often require a knowledge of the variability within the resource base. As archeologists, we strive to consider a wide range of human activities. Past human behavior has produced great variability in the archeological record. Only through the identification of a variety of site types will we be able to insure that management decisions allow for the preservation of the remains of the full range of past human behavior. In this light, the analysis has considered limited activity sites as well as habitation units.

Elevation

Elevation is often considered a prime variable affecting the human use patterns of an area. Moisture, length of growing season, and faunal and floral distributions are frequently related to altitude. Work in the Apache-Sitgreaves National Forest in the Pinedale region, Mogollon and Little Colorado Planning Units, has shown elevation to be an important factor in predictive models of site location (Lightfoot and DeAtley 1977; Lightfoot 1978; Lerner 1979; Wood 1978). In these areas, elevation has functioned primarily as a limiting factor; sites are generally not encountered above a certain altitude (7200 feet in Pinedale, 7000 feet in

Mogollon Rim Planning Unit, 8200 feet in the Little Colorado). This is not the case in Tusayan Planning Sub-Unit 1. Within the sub-unit, elevation ranges from about 6100 to almost 7500 feet. Relatively little of the planning unit is over 7200 feet. Although the lower elevations were sampled fairly well, none of the transects fell above 7250 feet. For the available data, sites do not appear to be differentially distributed by elevation. It is very possible, given the information from the Apache-Sitgreaves National Forest, that in the Tusayan Planning Unit there would be a sharp decline in the number of sites between the elevations of 7250 and 7500 feet. This could be easily tested by walking a few transects in these higher elevations.

In order to test whether archeological sites (both modern and prehistoric) are associated with specific elevations the following procedure was followed. An average elevation was calculated for each of the random transects (1 through 34) by averaging the highest and lowest elevations crossed by the transect. It is felt that this gives a reasonable estimate of average elevation since there was minimal altitudinal variation within each transect. The transects were then segregated into these groups; those with no sites, those with prehistoric sites, and those with Navajo sites Table 15 shows the range of elevations for these groupings. It is clear from this table alone that the degree of overlap between grouped elevations is sufficient to indicate that there is no association between elevation and the presence or absence of cultural resources.

The data were also examined to determine if particular types of sites were correlated with particular elevational ranges. Sites were divided into prehistoric habitations, sherd and lithic scatters, lithic scatters, Navajo sites and non-site areas. The number of sites, elevational range, mean, and standard deviation for these are listed in Table 16. (No statistics have been calculated for non-sites as the sample is too small.)

Inspection of Table 16 shows that all the site types are distributed within the full range of the sampled elevations in the Tusayan Planning Unit. It should be remembered that the non-site areas defined in this survey consisted exclusively of lithic artifacts, so that there is little analytical distinction between this category and lithic scatters. It is perhaps best for the present to view these two types as part of a single continuum.

The fact that elevation is not useful for prediction of site location in the Tusayan Planning Unit is not surprising. Within the other areas discussed above, differences in elevation are more severe than they are in Tusayan. It is apparent that the 1000 feet change in elevation in the sampled portion is not dramatic enough to have created differential use patterns based on this variable alone. Far more crucial variables appear to be vegetation and topography.

Landform

Procedures for consistently identifying and mapping landforms are somewhat problematical. No attempt was made in this study to arrive at a quantitative determination of the total area covered for each landform type. It is important, however, when sampling a region for archeological sites, that a

Table 15. Comparison of transects with and without sites by elevation.

	Elevation Range of Transects (in feet)	
No Sites	6315 - 7010	14 transects
Prehistoric Sites	6250 - 7210	19 transects
Navajo Sites	6335 - 7210	6 transects

Table 16. Average elevation deviation for different site categories. (All figures are in feet.) Only transect data is used.

	Habitation	Sherd & Lithic	Lithic	Navajo	Non-Site
Range	6220-7280	6400-7220	6540-6790	6110-7240	6860-7170
Mean	6740	6716	6712	6813	not given
Stand. Dev.	286	272	118	333	not given
TOTAL N	13	18	5	16	3

full range of landforms within the area be covered. We feel this has been accomplished in the Tusayan survey. The stratified sample has assured that various zones within the region would be covered. Furthermore, each transect covered a substantial range of microtopographic features. It seems safe to say that there is a good representation in the sample of the various landforms found within the Planning Unit. Table 17 gives a listing of site types by on-site landform.

When all sites are considered, 49 percent are found to occur on ridge crests. If the term "ridge" is extended to include all ridge parts (i.e., terrace on ridges and ridge slopes), the percentage of sites occurring on these features rises to 56 percent. Hillslope and flat areas have the next highest frequency of sites with 15 percent each. The fact that sites occur much more frequently on ridges and sloping surfaces in general has tremendous implications for management decisions concerning the use of these areas.

Table 17. Frequency of site type by on-site landform.

	SITE TYPE					
	Habitations	Sherd & Lithic	Lithic	Navajo	Non-Site	%
Ridges	9	7	1	8	2	49.1
Terrace of Ridge	1	1				3.6
Ridge Slope		1		1		3.6
Hill Top	1					1.8
Hill Slope		3	1	3		12.7
Flat		2	3	2	1	14.5
Terrace		2				3.6
Valley				1		1.8
Low Rise	1					1.8
Erosional Slope	1					1.8
Base of Rim		2	0	1		5.5
Total	13	18	5	16	3	99.8

Quadrat data are excluded.

Also of interest is the fact that with the exceptions of lithic scatters, sites are similarly distributed on the various landform types. Seventy-seven percent of the prehistoric habitations, 44 percent of the sherd and lithic scatters, 56 percent of the Navajo sites and 67 percent of the non-sites are found on ridges. Twenty percent of lithic sites are found on ridges. All the site types except pueblos are found on flats. When considered by category, this includes 11 percent of the sherd and lithic scatters, 60 of the lithic scatters, 13 percent of the Navajo sites and 33 percent of the non-site areas. It is likely that this preference for ridge locations is a combination of their ability to provide a dry location for habitation, runoff water for farming, and possibly micro-environmental differences in vegetational communities.

Vegetation

Vegetation has long been recognized as a factor in site location. Since prehistoric and historic peoples are known to utilize only a small portion of the available resources, we expect to find remains associated with the exploitation of key resources. Many plants and animals have distributions correlated with particular microenvironments, and it is reasonable to expect that the collection of certain resources or the use of land for particular agricultural pursuits will be limited to those environments best suited to these purposes. The Tusayan Planning Unit data show a substantial degree of patterning of archeological site location by vegetation zones.

Table 18 lists the various site types as they occur by vegetation zone. Only transect data has been used in compiling this table. The vegetation zones have been divided by their occurrence in the Upper Basin and Lower Plateau. Using this distinction one can see that habitations are tremendously more common in the Upper Basin. Combining all vegetation types, the density of masonry sites is estimated at 0.8/square mile in the Lower Plateau and 15.6/square mile in the Upper Basin. Sherd and lithic scatters are more than three times as common in the Upper Basin (14.5/square mile) than in the Lower Plateau (5.5/square mile). Both lithic sites and non-site manifestations (which are all lithic scatters) are found more often in the Lower than Upper Basin. Navajo sites occur primarily in the Lower Plateau although they can be found in the P-J/sage environment in the Upper Basin. Since these are thought to be principally pinyon gathering camps it is not surprising that they are found in highest density in heavy pinyon areas.

It appears that the heaviest site densities are found in areas with various associations of pinyon-juniper, with lower densities in areas of pure sage or pure ponderosa vegetation types. The following hypothesis has been formulated to test this observation: There is no association between site occurrence by transects and vegetation zones.

To test the hypothesis, transects were categorized by their regional vegetation and whether or not they contained sites. This is illustrated in the form of a contingency table (Table 19). Yates correction for continuity which is a version of Chi Square suited to contingency tables in which one or more cell frequencies fall below 5 (Thomas 1976:281) was used to test this hypothesis. Both Chi Square and Yates correction assess the probability that the observed distribution has resulted from chance alone. The

Table 18. Site density per square mile by vegetation zone and physiographic area.

Vegetation Zone	Area	Masonry Pueblos	Sherd & Lithic	Lithic	Non-Site Areas	Navajo
Sage/ Grassland	U.B.	0	0	0	0	0
	L.P.	0	0	5.0	0	5
	TOTAL	0	0	4.2	0	4.2
P.J./ Sage	U.B.	16.7	16.7	0	0	3.3
	L.P.	1.6	7.9	4.7	1.6	10.9
	TOTAL	8.9	12.1	2.4	.8	7.3
P.J./ Ponderosa	U.B.	12.5	12.5	0	0	0
	L.P.	0.0	8.3	0	4.1	10.7
	TOTAL	2.7	9.4	0	3.1	8.3
Ponderosa/ P.J.*	U.B.	25.0	0	0	0	0
	L.P.	0.0	0	6.2	0	6.2
	TOTAL	5.0	0	5.0	0	5.0
All Vegetation	U.B.	15.6	14.5	0	0	2.6
	L.P.	.8	5.5	3.9	2.4	9.6
	TOTAL	6.5	8.8	2.5	1.5	7.0

U.B. = Upper Basin
L.P. = Lower Plateau

* All of the figures for the Ponderosa/Pinyon-Juniper association are suspect because of low sampling fractions.

Table 19. Site Distributions Compared to Regional Vegetation.

	TRANSECTS		
	Sites	No-Sites	Totals
Sage/ Ponderosa Pine	2	5	7
Pinyon Juniper Dominant	21	6	27
Totals	23	11	34

X^2 (corrected) = 10.465 df=1
alpha = .0
Tau b = .70

Result: Association significant at the .01 level

test indicates that there is probably an association between Regional vegetation as defined above, and site occurrence. That is, there is a low probability that the above arrangement has occurred by chance. Tau b which is a measure of strength of association is equal to .70, which is very strong. In terms of management this means that one mile long transects in pinyon-juniper are likely to find sites 2.75 times more often than transects in sage or ponderosa. There are no implications for past human behavior.

Several possible associations could be postulated concerning the occurrence of particular site types with the various vegetation zones. One obvious and easily tested proposition is the relationship of Navajo sites with pinyon areas. More subtle is the association of pueblos with P-J and the different distribution of lithic scatters from those of other sites. Questions concerning differential land use patterns through time and with changing subsistence strategies arise from these observations. However, it should be emphasized that many variables, among them social factors which are not all accounted for by examining environmental variables, affect the distribution of population on the landscape.

Summary

The long-term benefit of this data set is that it has provided a basis for deriving a predictive model of site location and assessing the variability within the cultural resources of the Tusayan area. More detailed information concerning the sites in this report may be found in the Arizona State University arecheological site files. Materials collected at these sites are housed at the Department of Anthropology at Arizona State University.

The variability in the resource base may be summarized as follows. The survey encountered five basic site types: prehistoric architectural sites (habitations), sherd and lithic scatters, lithic scatters, Navajo sites and non-site areas. Non-site areas can at this time be considered a subgroup of lithic scatters. Several subcategories have been defined for these basic site types. These are 3 types of prehistoric structural units, 3 types of Navajo camps, and 2 types of artifact scatters. These differences may be attributable to differences in site functions and to behavioral changes which occurred through time. These proposed distinctions must be verified through subsequent research. It is not unlikely that other site types may be discovered or are already known but unreported in the area.

The model of site location has been based primarily on landform type and vegetation. Elevation has been examined and found not to influence site location within the Planning Unit. Landform provides a significant clue to the location of sites. Sixty percent of all sites located were on some portion of a ridge. This is not to say that all or even most ridges contain sites but rather that areas characterized by this topographic feature are more likely to contain sites than are other areas.

Vegetation has been used to develop estimates of site densities by vegetation type in both the Upper Basin and Lower Plateau. Overall density of sites is much higher in the Upper Basin. Prehistoric habitations and sherd and lithic scatters occur most frequently in the Upper Basin and lithic

scatters, non-site areas and Navajo sites are most dense in the Lower Plateau. Within both the Upper Basin and the Lower Plateau, sites are significantly associated with pinyon-juniper associations; pinyon-juniper/sage, pinyon-juniper/ponderosa pine and ponderosa pine/pinyon-juniper. Very few sites are found in grassland or pure ponderosa vegetation. The highest site densities occur within the P-J/sage environment. Some of the categories into which the data has been divided were sampled at a low intensity and the resultant estimates may be affected by sampling error.

The combination of the above information has given us some ability to predict the locations, type and density of cultural resources. This knowledge provides the basis for estimates of further work which will be needed to manage cultural resources and predict degrees of impact by various proposed land use projects. All the types of information and methods which archeologists presently control have not been utilized to construct the predictive model. Future work, especially that concerned with social variables, as well as more detailed environmental information would be useful in the development of a more accurate model. Hopefully, as archeologists strive to improve their present methods, predictive models will also be improved thereby aiding the cultural resource manager.

CONCLUSIONS

A one percent stratified random sampling survey of the Tusayan Planning Sub-Unit 1 in the Kaibab National Forest has provided an initial impression of the prehistoric and historic occupation of the area. It is estimated that there are about 4300 sites in the study area, of which 70 percent date to the prehistoric period. The survey has provided information about the spatial distribution and density of sites, the cultural affiliation of the sites, the chronological placement of a sub-set of the sites, and several interesting implications about the prehistoric Puebloan occupation of the area. Some of the more salient findings include the following:

1 - The major prehistoric occupation of the area was from the Basketmaker III through Pueblo II time periods, with only a limited occupation during the Pueblo III period.

2 - The local ceramic tradition shows a blending of Kayenta Anasazi and (to a lesser degree) Cohonina Patayan ceramics, although in other social and economic aspects the local systems may have been more thoroughly Anasazi-like.

3 - The Puebloan occupation is greatest in the Upper Basin area.

4 - Nearly 12 percent of the sites are aceramic, and the occurrence of archaic style points at some sites and in isolated contexts suggests that at least some sub-set of these lithic scatters could be affiliated with the Archaic period.

5 - The greatest density of lithic sites occurs in the Lower Plateau area.

6 - There is a pronounced absence of grinding implements in the artifact collections made from the prehistoric sites. It is suggested that even the Puebloan population occupying the area were not fully agricultural, but depended instead on a mixed economy of natural and cultivated resources.

7 - The historic Navajo use of the area is greatest in the Lower Plateau, and consists of temporary pinyon harvesting camps.

The study area has considerable research potential for studying cultural development from the Archaic through Basketmaker III and into Pueblo II time periods. There appear to have been changes in land-use patterns, with the Archaic populations using the Lower Plateau more heavily than the Upper Basin. This same spatial pattern is also observed for the Navajo pinyon-collecting camps, which suggests that there may be a structural similarity between the Archaic and the historic Navajo use of the study area. One feature shared by the two populations and which comes most readily to mind is that both followed a seasonal round and were in the area for only part of the annual cycle. By contrast, the sedentary Basketmaker III and Puebloan populations made much greater use of the Upper Basin than the Lower Plateau. Additional studies in the area could look for environmental parameters which might account for this difference in land-use patterns between seasonal and sedentary populations.

The survey has provided the statistical basis needed to make an inventory of cultural resources in Tusayan Planning Sub-Unit 1. It has also provided sufficient archeological information to indicate that major systemic and cultural changes characterize the prehistory of the area. There is also the suggestion that the historic Navajo occupation of the area could provide a structural analog for the study of the Archaic.

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